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Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

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

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CONTENTS—see page VII.

Is Public Interest in Science on the Decline in England?

WE sincerely trust not. The British Science Guild has lately been incorporated, under the Presidency of the new Minister for War, with the special object of guarding against such a contingency, and has all the appearance of having come to stay. And yet there is some evidence to the effect that periodicals devoted to scientific subjects are not read to the extent that we would like to see. During the past year no less than three such journals have died of inanition. One, a magnificently got-up and very well edited magazine of technics, another, a most useful organ of metallurgy, and the third an interesting record of nature. Yet these have each failed to attract sufficient readers to justify their existence. It is a monstrous pity! What is the cause? It is generally contended that scientific interest is growing apace, and that the general public is daily becoming more imbued with a craving for knowledge. If so, why these failures in the scientific press? As regards our own position, although not very long ago we also were deploring the scanty support we were receiving, times have changed, and, possibly in consequence of the disappearance of the other journals, the outlook is now far brighter than it was, and our position seems assured. Still, considering the circumstances, it might have been expected that a larger proportion of the reading public would have gone in for a journal devoted to science, while of not too technical a character. The modern public is, however, very critical, and even hyper-critical. "None but the best" is now the cry. Such a sentiment is praiseworthy, but it can be overdone, and if the acme of perfection is not to be obtained it is surely better to take the less good and encourage it to improve. Half a loaf is better than no bread, and the sale of many half loaves enables the baker to give more for the money.

A really good organ of popular science is a most desirable institution. We know, only too well, our shortcomings, but without more encouragement and a larger circulation it is not possible to produce a periodical such as we should like to see. We would, then, make a strong and earnest appeal to all who have scientific progress at heart, to co-operate in improving this journal by doing what they can to increase our circulation. If only each one of our readers would take two copies instead of one (and the spare copy makes an acceptable present to many a poorer worker in science), with our circulation doubled, we would gladly undertake to double the size of the paper, and pay more for suitable articles and choice illustrations.

It would be of the greatest assistance to the immediate improvement of the journal if all those who propose to take it in regularly would subscribe on the new five-years' system. This has been specially arranged to be of the greatest benefit to the reader, saving him much expense and trouble.

We occasionally have opinions from individual readers, but these are often contradictory and bewildering in their suggestions. We are anxious to ascertain the wishes of the majority, and with such object we enclose in this number a post card in the hope that all readers will kindly enter thereon their opinions and post it to us.

The Coloration of Mammals and Birds.

By J. Lewis Bonhote, M.A., F.L.S., F.Z.S., M.B.O.U., etc.

(*Continued from page* 294.)

Let us now study for a short time the migrant birds that breed in Polar regions. These may be divided into two classes :—

(1.) Those from the temperate regions, which gradually breed as far north as is consistent with their wants.

(2.) Those that winter in the tropics and breed in the extreme north, but not in the intervening region.

We need not notice the first class here, as they belong properly to the north temperate region, from which they are stragglers.

The second class consists, for the most part, of bright-coloured birds that assume their bright livery in the tropics, and that wear in winter a duller dress, assumed in northern regions*. The Lapland bunting (*Calcarius lapponicus*) is a good example, for the cock has a bright black and red breeding plumage, much brighter than that of its near ally, the snow bunting (*Plectrophenax nivalis*), which has a much more northerly winter habitat.

Another good instance of a bright-coloured northern breeding bird is the red-breasted swallow (*Hirundo erythogaster*), which passes the summer in North-East Siberia, and the winter in Burma, and countries to the south. This bird does not, as far as I am aware, moult in these northern regions, and, consequently, as we should expect, retains its bright red colour, which was assumed in the tropics (where the temperature and food are conducive to high vigour) throughout the year.

It would be impossible to enumerate all the birds which may be considered in this class; the Limicolæ offer many examples, and the knot (*Tringa canutus*) may be taken as very typical.

This bird assumes in early spring, when in the tropics, a very deep chestnut plumage. It then migrates to the extreme north to breed. After breeding it moults and becomes a dull greyish white bird, so that both its plumages are in keeping with the colour characteristic of the regions in which they are assumed. Now it has long been a puzzle to me why† the young knot, bred and reared in the north, should yet be able to assume a browner and pinker plumage than its parents, although in Arctic regions. The explanation may, however, possibly be due to the fact that when the old birds moult they have had a long journey immediately followed by the strain of the breeding season, compressed into the short Arctic summer, so that we would expect their vigour in autumn to be very low; whereas, on the other hand, the young bird has only had to grow, which is probably a far less strain on its system than that undergone by the parents. The result is that the young are enabled, although in Arctic regions,* to assume, to a slight extent, a colour belonging rather to the tropics.

This case is, to my mind, of considerable importance as showing that "colour" is dependent far more on "vigour" than on the particular latitude in which it is produced.

Knots, when kept in captivity, rarely, if ever, assume the full deep chestnut which they do when wild, the amount of change depending largely upon the individual. For two winters I endeavoured, by keeping these birds at a fairly high temperature, to induce them to assume their full red colour, but it produced no appreciable effect, showing, therefore, that heat has, in this species at all events, but little power.

The golden plover at first sight offers rather a puzzle, for in this species the birds, which nest in the southern limit of its range, are duller and in less perfect plumage than those to the north, which is apparently exactly the reverse of what ought to take place. It has, however, been proved for some species of birds, *e.g.*, *Geothlypis*, that those individuals of a species that breed the furthest north, winter furthest south, and, consequently, the full plumaged golden plovers that breed in the far north may presumably have wintered in the tropics, while those that breed with us have never entered the torrid zone.

Further evidence in support of this suggestion is given by that nearly-allied species, the grey plover, whose breeding range is entirely in the north, and that only occurs in the temperature zone on migration, for in this species all individuals assume their full summer dress.

To take a further example. The ducks may be roughly divided into two groups :—

(1.) Those in which the male assumes a dull plumage after the breeding season. (Restricted entirely to those species in which the sexes are markedly distinct.)

(2.) Those in which the male and female are similarly coloured. (Chiefly found in the tropics.)

Of this latter group, the long-tailed duck (*Harelda glacialis*) is the *only* species which occurs in Arctic regions.

This bird, moreover, differs in its plumage from all other members of the Anatidæ by the fact that there is a summer and winter plumage common to both sexes. According to our present theory, this is quite easy of explanation. The light-coloured winter plumage is assumed in Arctic regions after the breeding season; the winter is spent in temperate regions, and the summer plumage produced there (under conditions which must be very mild to an Arctic species) is brown.

II.—The Tropical Regions.

Leaving the Polar regions, where the contrasts of the seasons are greatest, let us now turn to the tropics, where the contrasts are least.

In the first place, the conditions are such that life can be carried on in a high state of "vigour" during all seasons of the year, and abundance of food in the shape of fruit and insects may be had in every month, the only seasonal differences being those of wet and dry. Although these naturally have a considerable effect in

* It has been pointed out to me that some birds migrate in autumn before they moult, which is sometimes undoubtedly the case, although I believe that in the majority of instances this is due to their being driven south by early storms before the moult has been completed. In any case the moult would follow so soon after migration that their system would not have had time to respond to the more generous influences of a southern clime.

† For further suggestion on this point see *P. Z. S.* 1901, p. 325.

* Of course the tendency of the species to assume red must be taken into account, as it causes the bird to be pink instead of brown on the breast, though the brown colour appears on the back. As I previously pointed out (*loc. cit. ante*), the red plumage is in this case probably the older plumage

determining the breeding seasons of many species of mammals and birds, yet the periods of drought and wet are so local, and determined to such an extent by the geographical conditions of the country, that they need not be considered in a paper dealing with the subject so broadly as the present one.

We are, therefore, not likely to find in the tropics great differences of colour, since any climatic change that may exist will tend not to coincide with the breeding season, and the latter will be spread over the greater part of the year.

From these reasons, therefore, it will be evident that the life of an animal will run much more evenly so far as its metabolism is concerned, and, food and temperature being favourable to a high state of vigour, we should expect to find animals deeply coloured and remaining so throughout the year.

Some animals, however, will be so weak that they can only exist where the conditions of life are most favourable, so that, although living in the tropics, their vigour will be low. Such animals, therefore, according to my argument, should be white or pale coloured, and restricted to the tropics, while the brighter-coloured tropical animals should be found to have a much wider range, the majority decreasing in colour as they spread north or south.

Of these brighter animals the tiger and leopard afford good examples. The buffalo of India is black, but in Assam a light variety is found, and the more northern species of Bos are found to be lighter in colour. The squirrels, another brightly-coloured group, are, like the oxen, cosmopolitan, shading through brown to grey in the northern regions.

White or grey tropical mammals are very scarce, but we may notice the bamboo rat (*Rhizomys sumatrensis*), which is dirty white in colour and does not range north of Burmah. *R. pruinosus*, a rather darker species, ranges as far north as Assam, while *R. badius* and *R. sinensis*, both dark brown species, range from the south as far north as Bhutan, Nepal, and even Thibet.

As regards the birds, we may notice the kingfishers and rollers, typical tropical families, which range to more northern climates.

The parrots, which by the same process of reasoning one would expect to find in more temperate zones, only extend to a limited extent. This is probably due to two causes:—

(1.) Their sedentary habits.

(2.) The fact that many of them are not as brightly pigmented as they appear on the surface, the predominating pigment being yellow.

On the other hand, many of them are perfectly hardy, and stand our climate out of doors well, so that probably their sedentary habits have been no small factor in restricting their range. Humming birds also range far to the north, but have to retreat before the winter, probably from lack of food, while the sunbirds of India are probably restricted by the Himalayas. The *Phasianidæ* are another example of bright-coloured tropical groups extending northwards.

Dull-coloured tropical birds (not counting those from temperate regions that have migrated to the tropics) are not numerous.

The hoatzin (*Opisthocomus*) is, however, a good example of a dull-coloured tropical bird, which, as we might expect, we find restricted to the tropics, while the bell birds (*Chiasmorhynchus*) form another good example.

(*Continued.*)

The Venom of Spiders.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

(*Continued from page 299.*)

The modern conception of toxines is based on Ehrlich's "side-chain" theory, according to which a toxine is a very unstable body, whose molecule may be represented as containing different unsaturated groups. One of these is termed the *haptophore* group, and it is that which combines with corresponding groups (*receptors*) in the attacked cells and enables the active or *toxophore* group to do its work. If there are no corresponding groups in the blood of the animal the toxine simply circulates inertly and finally disappears. A striking instance of this is seen in the effect of tetanus (lock-jaw) poison upon the alligator, for although the reptile itself is proof against the action of tetanus, its blood becomes toxic and will infect a susceptible animal, i.e., one whose blood contains suitable receptors for the toxine.

In like manner the hedgehog is refractory to snake venom, and also to spider venom, and its partial insusceptibility must be attributed to a lack of receptors, for the blood of a hedgehog that has been bitten becomes highly venomous.

It is further assumed in Ehrlich's theory that "side chains" are generated within the animal, to replace those of the cells fixed by the toxine, and these, being formed in excess, circulate in a free state in the blood and form the specific immune substance or antitoxine.

Now, spider venom answers all the requirements of a toxine, as defined by Dr. Ehrlich. It is unstable, and produces an antitoxine which is capable of neutralising its action when mixed with it in the right proportion. It resembles snake venom in possessing more than one active principle. In snake venom there is one toxine which acts upon the nervous system, a second acting upon the cell walls, and a third, termed a *hæmolysine*, which dissolves the corpuscles of the blood. Similarly, in spider venom there is one active principle, which acts upon the nervous system and heart, and another, a haemolysine, with a solvent action upon the red blood corpuscles.

This haemolysine has recently been separated from the common garden spider by Dr. Sachs, who terms it *arachnolysine*. It has a very energetic action upon washed blood corpuscles. Those of the rabbit, rat, and mouse are rapidly dissolved, while human blood corpuscles are less susceptible, and those of the guinea pig, sheep, horse and ox absolutely refractory. The blood corpuscles of young chickens are at first quite refractory, evidently from a lack of receptors to combine with the *haptophore* group of the toxine, but as the bird grows older its corpuscles become more susceptible, until after about a month they attain the normal susceptibility of the hen. Dr. Sachs also succeeded in producing an antitoxine, *anti-arachnolysine*, to this toxine by inoculating animals with gradually increasing doses. The serum of the animal thus immunised was very active, and when mixed with freshly extracted venom neutralised both its toxic and its haemolytic action.

There is thus no doubt about the existence of powerful toxines in the various species of lathrodectes and in the garden spider, and possibly in *Chiracanthium nutrix*, a South European species, and the reason why the bite of these is sometimes insignificant is that the quantity of venom injected is then too small to be effective.

The bite of the tarantula, *Lycosa tarantula*, the fierce-looking spider which is very common near Taranto (whence its name), was at one time much more dreaded than that of the malmignatte, and is particularly interesting from having been associated with that curious mental state known as *tarantism*, and its reputed cure by music.

This is described by Ferrantro Imperato, in a Natural History published in Naples after his death, in 1500, and the details he gives are amplified by subsequent writers in the early part of the 17th century.

In the Philosophical Transactions for 1671 (Vol. VI., p. 3002) we find an enquiry from Marten Lyster "as to the truth that a person bitten by a Tarantula be not ever when on his feet disposed to and actually dancing after the nature of a Tarantula, which never moves but by skippings. And if so, what are we to think and credit concerning such and such musical tunes said to be most agreeable and lending to cure of persons bit by a Tarantula?"

Robert Boyle also made enquiries from friends in Taranto, and was convinced of the truth of this music cure, which he ascribed to sympathetic vibrations in the patient (*Essay of the Great Effects of Motion*, 1690, p. 74):—"But the Eminentest Instance of the Efficacy of peculiarly modified Sounds is afforded by what happens to those that are bit by a Tarantula. For though the bitten person will calmly hear divers other Tunes, yet when a peculiarly congruous one comes to be plaid, it will set him a dancing with so much vigour as the Spectators cannot but wonder at, and the dancing will sometimes continue many hours if the Musick do so, but not otherwise."

Richard Mead, Physician to the King, published in 1745 a *Mechanical Account of Poisons*, in which one of the sections is devoted to the Tarantula. He describes various symptoms and asserts that "that the patient being asked what the ail is, makes no reply, or with a querulous voice and melancholy look points to his breast, as if the heart was most affected." He also describes the dancing cure at length:—"While the Tarantati are dancing they lose in a manner the use of all senses, like to so many drunkards, do many ridiculous and foolish tricks, talk and act obscenely and rudely, take great pleasure in playing with vine leaves, with naked swords, red cloths, and the like; and on the other hand can't bear the sight of anything black; so that if any bystander happen to appear in that colour, he must immediately withdraw, otherwise they relapse into their symptoms with as much violence as ever."

All kinds of fables were believed. It was asserted that the patient was only affected so long as the tarantula lived, that the spider itself danced to the same tune that cured the patient, and that each one had its own specific tune. "This curious frenzy of dancing was infectious, and even those who had not had the mental excitement of the Tarantula's bite joined in as madly as the patient. The disease was said to recur every year at the same time and to be cured again by the same music."

At the time that Robert Boyle made his enquiries, this epidemic of dancing was at its height, but even then experiments had been made to prove that the bite of the tarantula was not the cause of the mania. Dr. Sanguinetti, of Naples (1693), made two Tarantulas bite him upon the finger and found that the bite had no more effect than the sting of an ant; and his experiments were repeated by Dr. Serrao, in 1748, who concluded that the bite never produced serious results, and that music had nothing to do with the tarantula.

A letter from Dr. Domenico Cirillo, Professor of Natural History at Naples, is published in the Transactions of the Royal Society for 1770, in which he stated that there was absolutely no truth in the surprising cure of the bite of the tarantula. He asserted that each year the disorder lost ground, and that he was confident that in a little while it would lose its credit.

There are numerous other accounts extant, showing that the bite of the tarantula is not dangerous, either to man or to cattle, and these are fully supported by the fact that Dr. Kobert found the extracts from tarantulas to be quite harmless.

The only relic that now survives of the old dancing mania is in the name of the dance of Southern Italy, the *tarantella*, which, according to an old authority, was one of the dances of the *tarantati*.

Similar dancing epidemics have been known in other parts of Europe, notably during the 14th century, in the Rhine and Moselle districts, where men and women, old and young, danced from town to town, dancing in the streets, in the squares, and in the churches—everywhere.

As regards the Italian epidemics, there were probably cases in which the effects of the bite of a malmignatte were attributed to the tarantula, but in most instances fear was probably the main cause of the illness, and produced a state of hysteria, which found its expression in violent and uncontrolled dancing.

Scientific Sewage Treatment.

The Leek Sewage Farm.

IN Slater's book on "Sewage Treatment," published in the year 1888, there is the following passage:—

"Unfortunately there is no subject, outside the range of party politics, on which so much envy, hatred, malice, and all uncharitableness prevail as on the treatment of sewage."

The history of the many abortive attempts which have been made to deal in a satisfactory manner with sewage purification, together with the magnitude of the interests involved and the curious vested interests which have grown up, explain the generation of the atmosphere of prejudice, through which all efforts at improvement are looked down upon.

It has not in the least degree surprised the writer of this notice that, although the first sketch of the new method of treatment dates back to the year 1899, the first opportunity of practical application on the large scale did not arise before the year 1903, when the waterlogged condition of the Leek Sewage Farm and the evils attendant on that condition provided the opportunity.

At the beginning of the year 1903 the sewage from a population of 8,000 persons, together with refuse from various manufactures, had been discharged upon the Sewage Farm during several years, and at the lower part of the farm a large tract of land was actually under water, which covered a deep layer of black sewage mud. Every day matters were becoming worse, and the necessity had arisen to stop the flow of sewage, or, indeed, of liquid of any kind on to the farm. So desperate had the situation become that instead of allowing the fetid swamp to increase the Leek authorities might have been obliged to send the raw sewage down the storm overflow into the river and to continue doing so until a partial recovery of the farm had taken place.

Under these conditions a chance was offered for the introduction of the new and untried process. The tanks which received the sewage on its arrival at the farm were so small that none of the common processes of precipitation were applicable, but they were quite large enough to admit of excellent work being accomplished by the new process.

The installation of the new process was quickly accomplished, viz., in three weeks, and the cost was insignificant.

On April 3, 1903, the sewage began to flow into the first aerater charged with wood charcoal. On April 11, 1903, the discharge of liquid on to the sewage farm was stopped. Instead of the liquid being run from the tanks on to the surface of the farm and then left to percolate through the land, the liquid was provided with a connecting channel so that it might pass from the upper distributing system of channels into the lower collecting system and into the river without deluging the land.

Under the new order of things the Leek Sewage Farm recovered rapidly, the fetid marsh dried up and was ploughed and became cultivated land. The flourishing condition of the vegetables on the farm attracted public attention as the summer advanced, and there was a prospect of making a profitable employment of sewage.

The quality of the liquid discharged by the Leek Sewers is most variable, and the rate of flow irregular. The Leek water supply contains very little foreign material of any kind, the total solid residue amounting to only six grains per gallon. On Sundays when the sewers do not carry manufacturing refuse, the sewage contains about 60 grains per gallon, some of which is suspended matter, the rest being dissolved matter. The week-day sewage is very different. An average sample, taken on Wednesday, August 12, 1903, was very carefully analysed by the writer with the following results :—

Specific Gravity 1001.6.

One Gallon contained :—

	Grains.
Organic Matter	35·0
Soda Na_2O	33·0
Silica $Si\,O_2$	13·0
Alumina and Oxide of Iron	6·3
Lime $Ca\,O$ ..	3·5
Chlorine .	8·8
Undetermined .	12·4
Total solid residue .	112·0

The immediate effect of the treatment with charcoal and the action of the aerater was to reduce the solid contents to 90.3 grains per gallon ; and there was a further reduction to 66.0 grains when the effluent was allowed to deposit its suspended matter.

The importance of these results depends upon the care which was taken to ensure that the samples of sewage and sewage-effluent were true average samples and were strictly comparable with one another. They were the official samples collected by Mr. Farrow, the Sanitary Inspector, whose trustworthiness and accuracy in matters of this description are proverbial in Leek. Beginning at nine o'clock on the morning of August 12, 1903, Mr. Farrow collected a sample once in the hour and continued the work of collection until five o'clock in the afternoon. The nine samples were mixed together so as to form the average sample of the week-day sewage, which was sent to the writer's laboratory by the Sanitary Authority of Leek. In like manner the effluent collected just as the liquid issued from the two small tanks was obtained by Mr. Farrow and sent to the writer's laboratory.

The rate of flow through the two small tanks which had been converted into aeraters and charged with wood charcoal was about two-hours ; that is to say, each gallon of sewage issued from the tanks in the condition of sewage-effluent two hours after it had entered the tanks in the condition of raw sewage.

The alteration in the composition of the sewage during its two hours' sojourn in the tanks and its conversion into sewage-effluent is expressed as follows :—

	Raw Sewage.		Tank Effluent.
Specific Gravity ..	1001·06	..	1000·82
Total solid contents grains per gallon	112·0	..	90·3

The removal of the 21.7 grains corresponds fairly well with the diminution of density. The tank-effluent was turbid, and on keeping at rest for a period, and afterwards subjecting it to careful decantation it lost 24.3 grains of solid contents, the total solids per gallon having fallen to 66 grains.

On August 12 when the average samples were collected by Mr. Farrow, the connecting channel was not in use, and it was therefore impossible to collect a sample of liquid at the outfall into the Churnet which would exhibit the degree of purification attainable in the channels in the absence of land treatment.

In the next month, viz., on September 9 and 10, the connecting channel was brought into play, and after a twenty-four hours' employment of that channel a sample of effluent was collected at the outfall into the Churnet. The total solid contents was found to be 67.3 grains per gallon.

Under the actual circumstances prevailing at the Leek sewage farm these diminutions in the total solid contents of the liquids afford a most satisfactory proof of the accomplishment of the purification. The substances employed in bringing about this purification are atmospheric oxygen, water, and wood charcoal. The purification begins in the two small tanks, and goes on in the long channels (a third of a mile in length) which intervene between the tanks and the river Churnet.

The writer of this notice was present when, on April 3, 1903, the raw sewage, laden with a forty-eight hours' accumulation of solid excrement, was suddenly turned into the left-hand tank (which had been fitted up with the proper partitions and the requisite charcoal), and he can vouch for the instantaneous and complete success of the arrangements. Standing close to the tank he noted that there was no fetid smell whatever, but only a slight odour of soapsuds. Properly applied wood charcoal is, indeed, a most potent sanitary agent ; and the reintroduction of this agent into the working of sewage farms marks the beginning of a new era in sewage-purification.

In the year 1903 the writer spent 78 days in Leek and watched over the operation of the new system at the sewage farm. His last visit to Leek was on May 2, 1904. Up to that day (being a period of 13 calendar months) the new system was in operation in Leek, and the writer is now in a position to give an estimate of the consumption of charcoal. It is at the rate of one ton per thousand persons per annum.

The Disintegration of Saturn's Ring System.

By W. J. KNIGHT, LL.D.

IN his standard work on "Saturn and its System," Mr. R. A. Proctor has so lucidly and convincingly discussed the disintegration of the rings of Saturn and the consequent and recent formation of the dark ring that subsequent research has done little more than ratify the conclusions at which he arrived. It is therefore to be regretted that he has not extended his investigations to the phenomena of the outer edge of the outer ring, where problems of great beauty present themselves for our consideration.

Mr. Proctor remarks that the exterior diameter of the outer bright ring has not perceptibly increased, and suggests a resisting medium as the reason why. I would, with all respect, prefer to think of the accelerated satelloids, at the outer edge, being thrown off bodily, like fragments from the rim of a rapidly revolving grindstone. The subsequent fate of such a satelloid is full of interest. The path it would describe would be that due to the resultant of the three forces acting on it at the moment it started on its separate career, viz., the force producing its orbital motion, in conjunction with Saturn round the Sun; the force inducing rotation around its primary, and the force of impact. This path would lie in a plane but little inclined to the plane of the rings, but might have any direction in that plane, depending on its instantaneous path at the moment when it left the ring. Dismissing from our consideration all but those trending sunwards, let us follow these tiny planetoids as they trace out their spiral orbits towards the sun. At first invisible, owing to their small size and great distance, the larger ones become perceptible, when, in the absence of The Giant Planet, they succeed in crossing the orbit of Jupiter and are registered in our catalogues as The Planetoids, Ceres, Pallas, Juno, Vesta, with hundreds of others of kindred origin. All, however, are not so successful. Attempting the passage near Jupiter itself, the influence of its mighty mass is sufficient to tear them from their independent orbits and to compel them to assume the subordinate positions of satellites of Jove. The motions of these satellites is direct if they are arrested whilst crossing in front of Jupiter, but retrograde if behind. Possibly the Great Red Spot indicates the fate of one which actually collided with Jupiter itself. After passing the orbit of Jupiter, the track of the planetoids was clear until they approached the orbit of Mars, which they appear to have done quite recently, two, Phobos and Deimos, assuming the *rôle* of Marsian Moons, and one, Eras, passing within that orbit and holding out to terrestrial observers the possible acquisition of a second Moon by the Earth itself.

As a confirmation of our theory, it should be observed that the orbits of all the planetoids have but a small inclination to the plane of the rings, but we have yet to assign the causes, both of the disintegration of the rings and of the spiral form of the planetoidal orbits. We take these in order. Saturn, though probably the hottest planet of our system, is yet a cooling body, and the rings, from their extreme thinness and great extent of surface, are cooling much faster than the planet. What wonder then, since the rigours of an arctic winter can split up the crystalline rocks of Spitzbergen, though shielded by the earth's atmosphere—what wonder that the fearful cold of interstellar space should crumble up the rings of Saturn? The wonder would be if it did not. Here, then, we have a simple but adequate explanation of this phenomenon. Let us now investigate the form of the orbits of the satelloids after assuming an independent existence. We shall best do so by making our observations from the sun, at a time when the plane of the rings passes through it. A straight line joining the centres of sun and planet would then cut the outer edge of the outer ring in a point occupied by a satelloid, which we will call "Quesita." Just prior to impact, the whole saturnian system is moving eastward with a velocity just sufficient to counterbalance the attraction of the sun, but, as Quesita is in inferior conjunction with Saturn, it appears to lag behind the planet in its eastward course, and if now it receives an impact from a following satelloid, it is detached from the ring, is abandoned by Saturn, and left, with diminished velocity, to pursue its eastward path alone. But, as its velocity *before* impact was only just enough to balance the attraction of the sun, its velocity *after* impact is insufficient for that purpose, and so Quesita is drawn sunwards. The amount of this disturbance may be small at first, but, as there is no force to increase the orbital velocity of Quesita, and as the sun's attraction increases as the inverse square of the distance, the planetoid is continually deflected from its instantaneous orbit and forced to describe a spiral curve, at first differing little from its original ellipse, but becoming more and more inclined to it as the years roll on, until it will finally terminate in the sun itself, just as the spiral orbits of the satelloids of the Crape Ring are rapidly approaching the body of the planet. As a further corroboration of our theory, it may be noted that recent observations have shown the necessity of applying "corrections" to the elements of Ceres, Pallas, Juno and Vesta. These corrections being required, not because the former observations were faulty, but because, being applied to an elliptic orbit, they failed to give the position of a body really describing a spiral curve. Still, as these helicoids are not greatly different from ellipses through several revolutions of the planetoid, it may be still convenient to calculate their places by means of the approximate ellipse and then apply corrections from time to time.

CORRESPONDENCE.

Magnetism of the Sun.

TO THE EDITORS OF "KNOWLEDGE."

SIR,—M. Salet, appointed by the Paris Bureau des Longitudes, to observe the late eclipse, in Algeria, made observations on the magnetic field in the neighbourhood of the sun by observing the amount of deviation in the plane of polarisation of the coronal light. The plane of the bands was found to be deviated in the right-hand direction 2 S. This visual observation was confirmed by photography which showed the plane of polarisation to be almost radial.

The sun, therefore, has very little magnetism.

Magnetisable material can be made a magnet by surrounding it with a belt of electricity; but if completely surrounded by a sphere of electricity there could be no poles and no magnet. This is nearly the case with the sun, the electrical activity of which is nearly equal over its whole surface, and were it not for the slight increase of electricity which pervades the sunspot bands, it would have no magnetic force at all. W. BADGLEY.

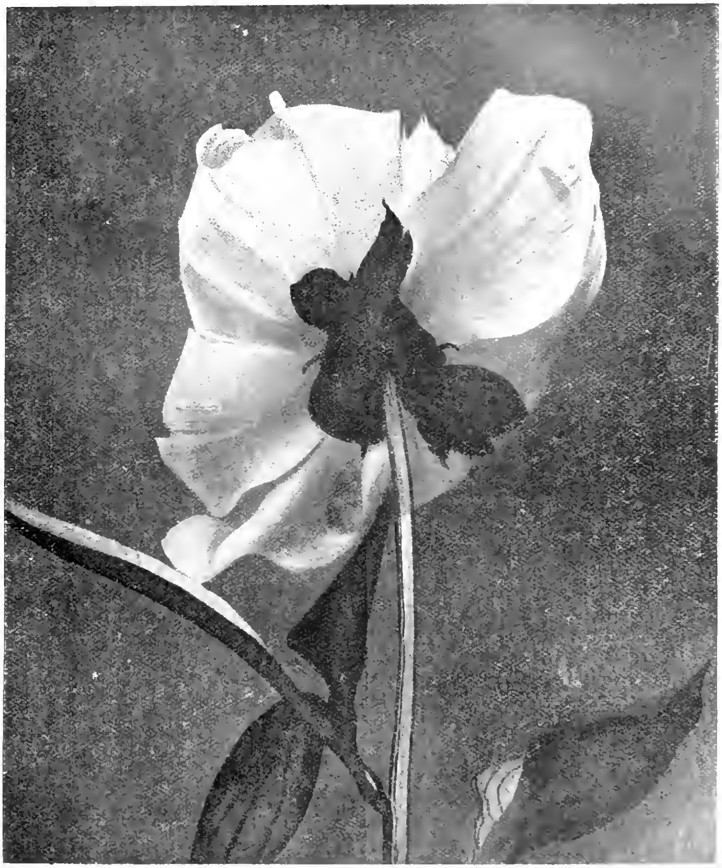
Exmouth, November 24, 1905.

The Evolution of the Flower.

By S. LEONARD BASTIN.

PART I.

BROADLY speaking, without the complicated system of organs to which, as a whole, we have given the name flower, the blossoming plants could not continue to exist. With certain exceptions all the host of diversely formed plants which produce flowers are solely and entirely dependent upon the offices of the floral organs for the perpetuation of their kind. Some species, it is true, seem to be able to flourish and increase apart from the services of the flower—for a time, at any rate. A notable instance of this may be cited in the case of the Lesser Celandine (*Ranunculus ficaria*), in which plant a great deal of the increase is carried out by means of the small tubers which are to be found thickly clustered round the root stock. Some authorities go so far as to say that the Lesser Celandine only very rarely produces fertile seed. Numerous other kinds of plants are also able to propagate their kind by root increase, runners, and such like methods. But, as any florist is only too well aware, these processes are only really extensions of the original parent, for new *individuals* we must look to the seed. This brings us back to the all important flower, and it will be the endeavour of the present paper to try to show by means of natural examples in what this indispensable body of organs had its origination.



THE PÆONY.—In the calyx of this flower, it is often seen that the sepals resemble leaves.

It may be of interest to refresh the memory regarding the number of parts which go to make up the typical flower. Starting from the outside of the bloom we find the calyx; this consists of a number of sepals which may be green or coloured. Enveloped in the calyx is the corolla formed of a number of petals usually coloured to a greater or less degree. In the centre of the flower we find on the outside a certain number of the pollen-producing stamens, whilst in the middle of all is the group of carpels which go to make up the pistil. For the present purpose it will be all sufficient to think of the flower as consisting of these four parts—calyx, corolla, stamens, and pistil. As well, in not a few flowers, there are present a number of appendages to which has been given the name bracts.

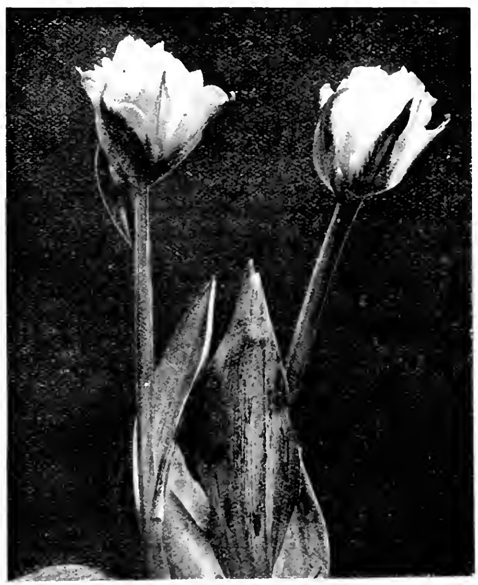
MOON DAISIES.—It is interesting to note the manner in which the leaves become more like the bracts as they approach the flower.

As has been stated, the calyx of the flower is sometimes green and sometimes coloured. This is equivalent to saying that the sepals on occasion produce chlorophyll, and in this condition they, of course, carry on the functions of an ordinary leaf. This being so it is interesting to see whether it is possible to discover any relation between the sepal and the leaf other than the fact that both indicate the presence of chlorophyll. In this connection the case of the ordinary herbaceous Paeony is very noteworthy. If a number of specimens of this flower be examined it will be found that quite often the sepals of the calyx are really modified leaves. Indeed, time and again it is impossible to determine definitely the exact nature of the organs, and the confusion is all the greater when, as is often the case, a large area of the leaf-like sepal is as gaily coloured as a petal.

The common Moon Daisy of the meadows (*Chrysanthemum Leucanthemum*) reveals in the nature of its growth the whole course of the evolution of the green bracts which encircle the mass of ray florets. Gather one of the long-stemmed blossoms, taking care to pluck it with as many of the lower leaves attached as possible. Now, starting from the bottom of the stem where there is nothing but the typical well-developed leaves of the species, allow the eye to travel upwards towards the flower head. With every fresh stage in the approach to the top there is a notable decrease in the size of the leaves. Finally they lose their distinctive form altogether, until just below the flower the leaflets drift into simple lobes, which bear a striking resemblance to the green bracts which form such an important part of the flower head.

Numerous instances might be noticed in which it would be clearly seen that we shall not be far wrong in assuming that the green sepals of the calyx are really nothing more than advanced leaves. But these sepals are often as gaily coloured as the petals themselves, being entirely devoid of the green tissue which is present in the leaf. In certain species, such as the Campanulas, the sepals and petals are actually joined together to form one big bell-shaped corolla. Under these circumstances it may not be amiss to consider for the time being both the floral appendages, whether sepals or petals, as one and the same thing.

The common garden Tulip is a well-known example of a flower in which the petals and sepals are identical; at any rate, as far as the ordinary observer can say. Now if we observe a large number of cultivated Tulip blossoms we shall certainly find that in not a few some of the sepals—that is to say, the outside circle of appendages—are partly or wholly green, proving beyond a shadow of a doubt whence they have their origin. This is especially so in the case of double Tulips, and the reason for this is probably owing to the fact that the double flower is a more artificial form of Tulip than is the single variety. It is well known that the more highly cultivated and artificially specialised is a plant the greater is the tendency to variation and reversion to early types. Moreover, in the Tulip, just below the flower a strange leaf-like appendage is often produced, and the intelligent observer will readily see in this a kind of half-way house between the leaf and the sepal.



TULIPS.—In double varieties of this flower the leaf origin of the calyx is very apparent.

Perhaps a still more striking proof of the leaf origin of both petals and sepals is to be seen in the flower of the Summer Snowflake (*Leucojum æstivum*). Each portion of the perianth is tipped with a dot of pure green, and this spot stands out in vivid contrast to the snowy whiteness of the rest of the organ. For what special purpose this conspicuous marking of green may have been retained it is not easy to say; it is all sufficient, however, to show to the student the leaf ancestry of the sepals and petals.

all of a green colour. If examined closely these are seen to be nothing more than diminutive leaves, and they even go so far as to retain the toothed edges which are so familiar a feature of rose foliage.

The change of the leaf into a coloured sepal or petal is not, after all, very remarkable, for coloured leaf-like organs, which really exhibit their character in every

Bougainvillea glabra.—**A splendid South American species with showy bracts.**

We can find at least one example belonging to an advanced family which has not found it necessary to produce any coloured sepals or petals for its flowers at all. The Green Rose (*Rosa viridis*), a curious variety of the China Rose, is, as its name suggests, entirely without any coloured blooms. Yet this flower is possessed of a number of sepals and petals, but they are

respect except that they are not green, are not at all uncommon. One of the most striking plants exhibiting this change of colour in the leaf is a South American species, *Bougainvillea glabra*, specimens of which are fairly often grown under glass in this country. The real flower of the *Bougainvillea* is a small yellowish blossom, of a much duller hue and nothing like the striking appearance of our Cowslip. These are produced in clusters of three, and would scarcely be noticeable amongst the foliage were it not that each cluster of blooms is surrounded by three conspicuous bracts. These bracts are exactly in the form of leaves, but are coloured in a highly attractive tint of bright lilac. Presumably this strange development is to attract the attention of insects, as a Bougainvillea in full bloom is an object which would be conspicuous from a considerable distance. In much the same fashion Brazilian Euphorbia (*Poinsettia pulcherrima*) has been able to call attention to its green flowers by surrounding these with a circle of bracts coloured with the brightest crimson. In each of the cases mentioned above it is impossible for the student to determine definitely whether the bracts may be referred to as leaves or petals.

THE SUMMER SNOWFLAKE.—In this flower the leaf origin of the petals and sepals is easily discernible, each organ having a green spot.

A more familiar plant than either of the showy exotics referred to is the *Salvia horminum rubra*, a common garden species. This plant has seen fit to resort to extraordinary means to advertise its small labiate flowers. When the Salvia is in bloom the terminal leaves of each flowering spike are coloured in the brightest pink. That these are true leaves is very evident from the fact that as one proceeds down the stem it is possible to find leaves which are half green and half pink, until one arrives finally at the wholly green leaves.

A further remarkable proof of the fact that the petals and sepals of the flower have their origin in the leaf is to be seen in the case of such a species as the Christmas Rose. This plant, as is well known, produces white blossoms during the winter time. What one may call the corolla of this flower is peculiarly tenacious in retaining its position on the stem, even after the essential organs of the flower are past their maturity. This corolla is really made up of petal-like sepals, the real petals being small processes scarcely distinguishable from the stamens of the flower. But the curious part about these white sepals is the fact that when the flower is "over" they do not fade away as one might expect, but gradually lose their whiteness and eventually become green and leaf-like in appearance. Much the same process goes on in the case of the Hydrangea and its showy bracts. Of course, it is well known that the attractive part of the Hydrangea heads of bloom are merely showily coloured bracts surrounding inconspicuous flowers. These bracts remain long after the real flowers have faded, and gradually lose their colour, finally becoming as green as the leaves of the plant itself.

Moreover, there are many species of plants in which the coloured parts of the flowers gradually develop from very green material. This is seen in the case of some of the Guelder Roses (*Viburnum*). As a matter of fact, in many species the undeveloped sepals and petals practically perform the offices of leaves during the early stages of their existence.

Numerous instances might be cited in support of the examples given above, but these would be little more than a reiteration of similar facts. Regarding the evolution of the sepals and petals of the flower from the leaf the case is surely a proven one beyond all doubt.

(To be continued.)

Star Map. No. 7.

Virgo, Corvus, Centaurus.

THE important features included in this map are the first magnitude star Spica and the Southern Cross. The objects of special interest are not numerous.

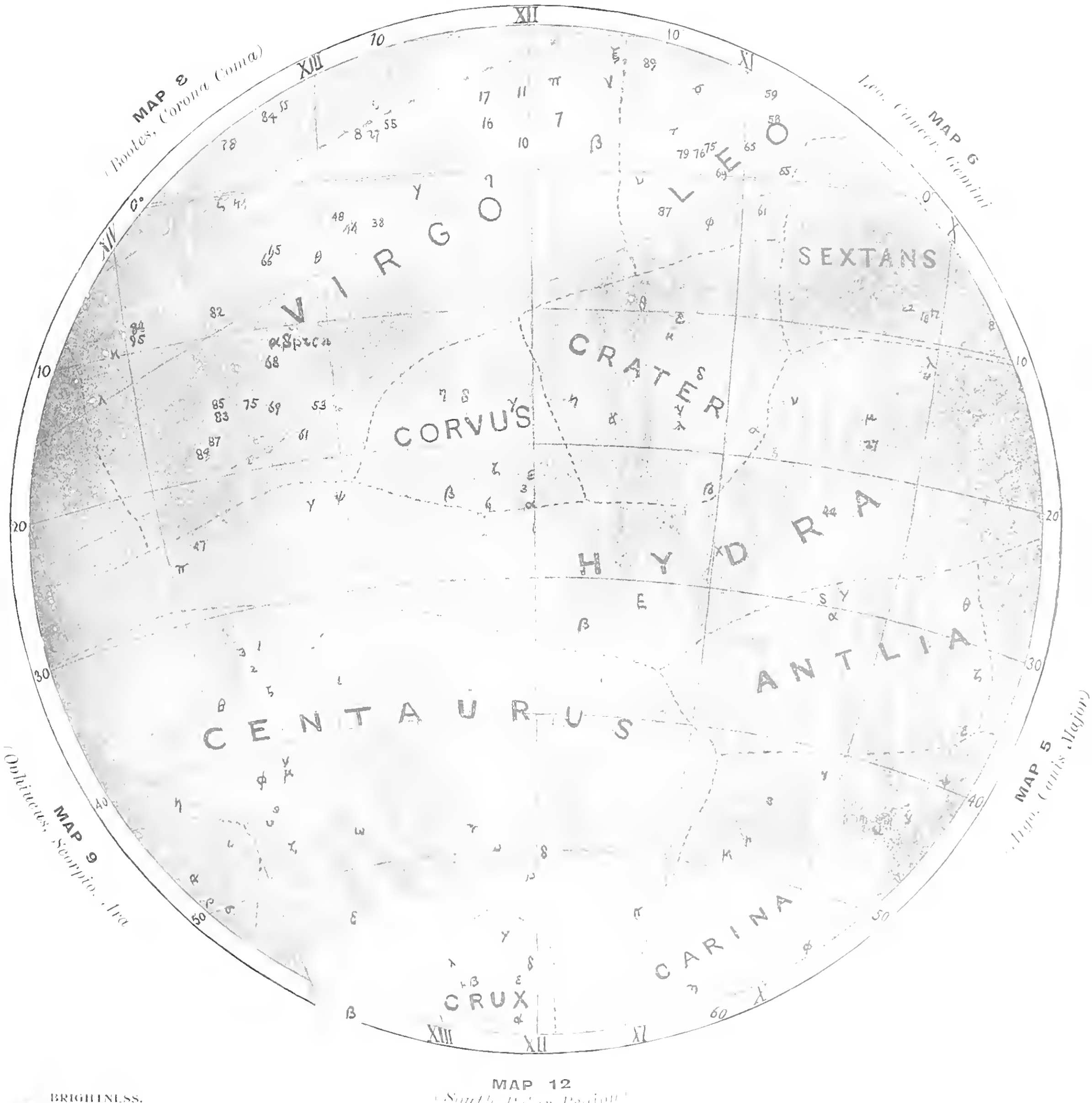
27 *Hydra* (X h. 20 m. – 18°). A planetary nebula. Spectrum gaseous.

γ *Virginis* (XII h. 37 m. – 0° 56′). A binary, distance apart 5″·74.

α *Virginis* (*Spica*) (XIII h. 20 m. – 10° 40′); 1·2 magnitude. Shown, by the movement to and fro of the lines of the spectrum, to be a binary with a small or feebly luminous companion.

ω *Centauri* (XIII h. 21 m. – 46° 57′). A fine star cluster, visible as a hazy object to the naked eye. Contains some 6000 stars, of which 125 are proved to be variables.

The following are the Lecture Arrangements at the Royal Institution, before Easter:—A Christmas Course of Six Illustrated Lectures, adapted to a Juvenile Auditory, by Professor H. H. Turner, on "Astronomy." Professor E. H. Parker, Three Lectures on Impressions of Travel in China and the Far East; Professor William Stirling, Six Lectures on Physiology Subject; Dr. J. E. Marr, Three Lectures on the Influence of Geology on Scenery (the Tyndall Lectures); Rev. Canon Beeching, Two Lectures on Shakespeare; Mr. Benjamin Kidd, Two Lectures on the Significance of the Future in the Theory of Evolution; Mr. H. B. Irving, Two Lectures on the English Stage in the Eighteenth Century; Mr. Francis Darwin, Three Lectures on the Physiology of Plants; Professor B. Hopkinson, Three Lectures on Internal Combustion Engines (with Experimental Illustrations); Mr. J. E. C. Bodley, Two Lectures on the Church in France; Mr. J. W. Gordon, Two Lectures on Advances in Microscopy; Mr. M. H. Spielmann, Two Lectures on George Frederick Watts as a Portrait Painter; and Professor J. J. Thomson, Six Lectures on the Corpuscular Theory of Matter. The Friday Evening Meetings will commence on January 19, when Professor J. J. Thomson will deliver a Discourse on Some Applications of the Theory of Electric Discharge to Spectroscopy. Succeeding Discourses will probably be given by Professor S. P. Thompson, Mr. H. F. Newall, Mr. W. C. D. Whetham, Dr. R. Caton, Dr. Hutchison, Sir Andrew Noble, Bart., Professor P. Zeemann, Mr. W. B. Hardy, and other gentlemen.



BRIGHTNESS.

1st Mag.
2nd ,,
3rd ,,
4th ,,
5th ,,
6th ,,
Variable
Nebula.

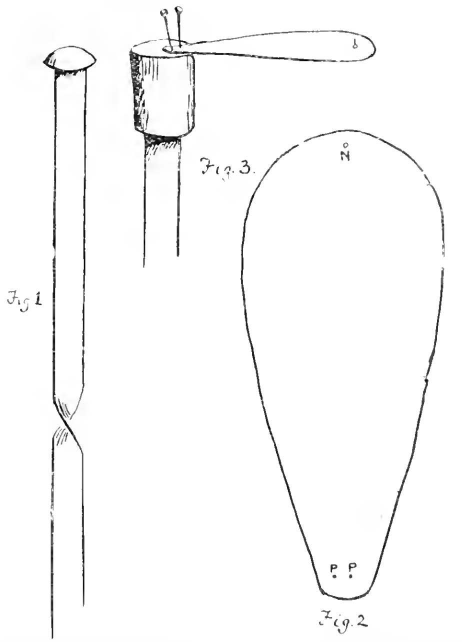
MAP No. 7.

Virgo, Corvus, Centaurus.

A Simple Harmonograph.

By CHARLES E. BENHAM.

THERE is a well-known modification of Wheatstone's Kaleidophone, in the form of a piece of clock spring, twisted so that it is divided into two sections, the flat surfaces of which are at right angles to each other. A bright bead is affixed to the top, and the spring is held firmly in a vice. (Fig. 1.) When thus gripped at appropriate places the two planes of the twisted spring, being at right angles to each other, communicate to the bead when they vibrate harmonious curve movements,



which are revealed to the eye when a beam of light falls on the bead, the reflected point of light becoming by the persistence of vision a luminous track.

Hitherto, however, no attempt appears to have been made to render this simple harmonograph self-recording. The luminous track has, indeed, been photographed, but the trouble involved makes it hardly worth while to adopt this method of registering the curves. As a matter of fact, it is an extremely simple thing to make the spring record its own movements either with a light glass pen, or with a fine point on a smoked surface.

If in place of the bead in Fig. 1 the spring were surmounted by a flat top, it is clear that a lever pen, resting on that surface, would describe the curves there, but the difficulty would be to make the pen rest lightly enough to avoid disturbing the movement, and yet rest firmly enough not to bounce with the rapid vibration.

Such a lever is, however, quite practicable, and it will be found most satisfactory to attach it to the spring itself, the recording being done on a stationary surface.

In place of the bead [illegible] the head of the spring, and to [illegible] the cork is affixed by [illegible] paper of the shape and [illegible] must be fairly stiff; ordinary [illegible] quality answers as well as any [illegible] to preserve the cut-out piece [illegible] in any part. The narrow end [illegible] and near the other end a very [illegible] half an inch in length, is passed through the [illegible] vertically so that the point projects about one-eighth of an inch beyond the lower surface. The top of the [illegible] point should have been previously warmed and headed with a drop of sealing wax, and when the needle has been inserted in position a lighted match applied near the sealing wax head will cause the wax to melt and run down the needle to the paper, thus securing the needle firmly in position. The paper [illegible] with the

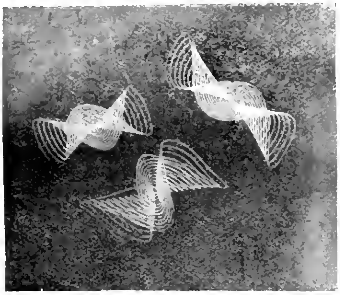
Harmony [illegible] 2.

point at one end and the pins affixing it to the [illegible] the other, is shown in Fig. 3. It should [illegible] slight curvature from its own weight. [illegible] glass on which the point is to work is [illegible] retort stand or in any convenient way [illegible] can be adjusted as required. When thus supported the paper strip should stand horizontal.

This delicate recorder, while [illegible] enough [illegible] purpose required, is [illegible] light and unresisting to register without seriously impeding the movements of the spring, and with careful manipulation it is free from any tendency to rebound.

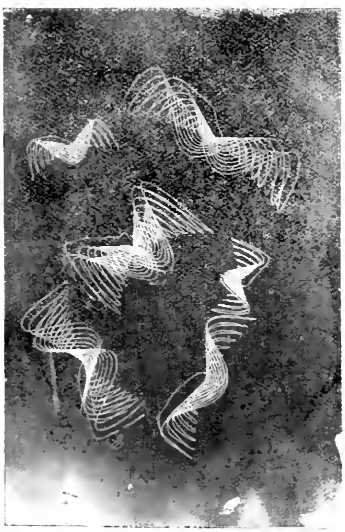
The smoked surface for the tracings may be a [illegible] plate of glass which has been [illegible] with [illegible] and drained at the corner, taking care, of course, [illegible] bring the benzoline can near the [illegible]. It should be smoked with a quick movement [illegible] not too heavily, but until the [illegible] darkened coating of carbon [illegible] slightly adherent to the glass [illegible] and there will be no undue friction. A face card may also be used, smoked in the candle flame, taking care to keep it moving so that the surface is not actually burned. The card or glass is laid on a small flat board, supported on the ring of a retort stand or other convenient adjustable support, so that it can be raised exactly to the height of the recording needle.

The spring having been fixed in the vice so that it is



Harmony 1 : 3.

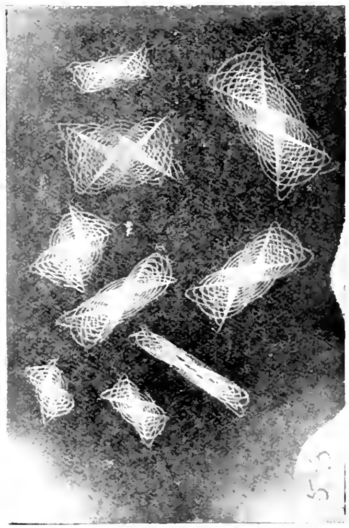
in tune, *i.e.*, so that when vibrated the light on the pin heads shows a curve of harmony, retaining its initial phase, the end of the paper strip near the pen is lifted with the tip of a paper knife so that it is just above the paper, and, keeping it thus supported, the spring is drawn gently in a diagonal direction and released, the paper knife being withdrawn at the same moment and



Harmony 1 : 4.

the curve of harmony is described on the smoked surface with almost magical rapidity. The paper strip must be lifted always by the extreme end and never unnecessarily high, or the "spring" of the paper may gradually be modified and the needle will not fall properly. The same thing may occur if the strip becomes bent or creased, but with moderate care these dangers are easily avoided. Harmonies from four to one downwards may be obtained from one and the same piece of spring by gripping it at different intervals in the vice. Unison and approximate unison figures are obtainable with a straight wire in place of the twisted spring.

Great accuracy is desirable in ensuring a perfect harmony. The curve shown by the bright pin heads should, in a harmony, retain its phase throughout the movement as nearly as possible, and it will be found that a very little movement up or down of the spring is sufficient to throw it into discord or bring it into harmony as the case may be. The harmony should, of course, be secured with the lever in position working upon plain glass or paper, as the weight of the pins and paper strip has to be taken into account. The different phases of the same figure are rendered by the different directions in which the spring is started. When once



Harmony 3 : 5.

the various harmonies have been found they may be conveniently marked in ink on the spring by a line at the position where it has to be held by the vice. The length of the spring above and below the twist will, of course, depend upon the size of the spring. An ordinary piece of clock spring of about twelve inches length twisted at the middle will be found to answer.

The smoked tracings may be fixed by pouring a thin spirit varnish, much diluted with spirit, over the surface, and the glass tracings thus varnished can be used as negatives to print from photographically.

To execute the tracings in ink a fine capillary tube is substituted for the needle. It is made in the same way as the ordinary harmonograph glass pen, by drawing the tube to a point, sealing and grinding down till the hole is reached; but only the tip of such a pen must be used, so that after it has been made the end must be cut off—about half an inch, and this is fixed with sealing wax through a hole in the paper strip in place of the needle. A tiny piece of cotton wool or worsted is inserted in the top opening, and the pen is filled with a small brush with violet or other dye, the supply being generally enough for at least 20 figures.

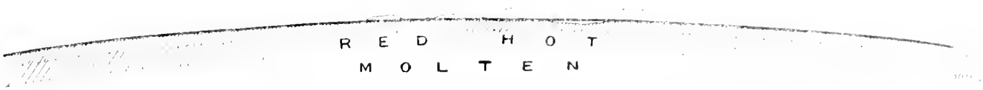
What is at the Centre of the Earth?

WE happen to have received recently three different articles bearing on this subject, and, considering the interest, the mystery, and the importance of the question, we think it desirable to publish them in series, and hope they may elicit comments and criticisms from other writers.

It seems remarkable that though we are able to investigate the composition of stars millions of miles away, and though (with the exception of a few comparatively small patches) we know every inch of the surface of the globe, and have investigated its composition to the smallest particular, yet we have not the slightest idea of either the chemical composition or physical state of what exists but a very few miles beneath our feet.

The diagram given below, which is taken from the *Science Year Book*, illustrates this in a most convincing manner. A glance at this is sufficient to make us doubt the possibility of the theory very generally held that the temperature increases so rapidly that substances of the earth at so small a depth from the surface as 30 miles, or only $\frac{1}{260}$ of the diameter, is at a heat sufficient to melt the most refractory substances known.

There are but few data to go upon. It is generally supposed that the earth weighs about $5\frac{1}{2}$ times as much as would an equal bulk of water. The specific gravity of granite, of which the greater part of the *known* world seems to consist, is only 2.6. But the pressure of the superincumbent strata would be so enormous on the underlying portions a few hundred miles down as to greatly increase its density and raise its melting point. But this pre-supposes the earth to be solid throughout. If the interior be hollow, many other considerations come in. We shall see, however, whether theories of a hollow interior can be considered tenable.



The Interior of the Earth.

By BERESFORD INGRAM, B.A., F.C.S.

IT is generally conceded that the present shape of the globe is due to the fact that at one time the earth was a semi-fluid mass which revolved round its axis with a definite uniform velocity.

Experiments have been conducted with spheres of plastic material rotating with different velocities round their axis. These have proved indubitably that, under the above conditions, a flatness is always produced at the two extremities at which the axis emerges, while a corresponding increase in diameter is observed midway between these two extremes. It was also noticed that the greater the velocity of rotation, the more *oblate* the mass became.

Nevertheless, there are, in this, many experimental considerations which would not be applicable to the earth in its earliest history; so that while the plausibility of the demonstration must be fully admitted, it would be unwise to accept the supposition as conclusively established.

On the other hand, there does exist absolute proof that the earth is a cooling body. The high temperatures that have been registered at the bottom of mines and deeper borings prove the point beyond all doubt that, as the centre of the earth is approached, the temperature becomes higher. Heat must, therefore, be travelling from the interior to the surface, and thus daily dissipated, in almost inconceivable quantities, into space.

Taking the average of all the observations, it would appear that the temperature rises 1° Fahr. for every 51 feet of the earth's crust penetrated. It follows that, at a distance of less than two miles, the temperature is the same as that of boiling water; while at a distance of 30 miles below the surface, the temperature is sufficient to melt iron; in fact, at a distance of 50 miles the temperature is higher than any that has yet been artificially produced. There still remains the best part of 4,000 miles to travel before the earth's centre is reached. It would, therefore, be meaningless to calculate the temperatures that exist below fifty miles.

The existence of enormous temperatures naturally raises the question, What is the condition that prevails in the interior? Is the rock in a liquid condition, or can it conceivably be in any other state?

On this point geologists seriously disagree.

Undoubtedly as the earth's crust is penetrated a temperature must be reached which is sufficient to melt solid rock under ordinary circumstances, but it is equally certain that at that depth an enormous pressure is affecting the underlying mass. Now it is well known that if the pressure on a solid is increased the melting point of that solid becomes higher, and, moreover, that different substances are differently affected by the increase in pressure.

As it is not known what is the composition of the rocks that exist at these great depths it becomes impossible to do anything but conjecture what effect the pressure has on the melting point.

When the pressure is relieved in any way (as is supposed to have taken place in volcanic outpourings of lava) it would appear that the condition necessary to keep the rock in a solid state is destroyed, with the observed result.

These considerations have led some scientists to consider the earth as a solid mass with its interior at a very high temperature.

But it may happen that the increase in pressure at certain depths is not sufficient to prevent the liquefaction of the rock, in which case the earth would have a solid crust with a liquid interior.

It may be, however, that, after a certain depth, the pressure becomes great enough to prevent further liquefaction, in which case a section through the earth would show three concentric rings, the innermost having a diameter of over 7,500 miles and marking the extremities of the solid nucleus, then a ring, about 7,800 miles in diameter, defining the limits of the liquid substratum, and finally there would be the earth's crust, which, varying as it would according to the position of mountain, land, and water, probably in no place exceeds a depth of over 70 miles.

A very potent argument has been urged against this second assumption to the effect that, if the crust were so thin as the theory states, it would yield to the deforming influence of the sun and the moon; in which case the water would be drawn up with the earth, and thus no sensible tidal effects could be produced. In order to counteract this attraction it would be necessary to admit that the thickness of the earth's crust is at least 2,000 miles.

An unsatisfactory compromise has thus been suggested, by which it is supposed that the earth is at the present time solid throughout (having passed through the stage of alternate solidity and fluidity), but that large fluid cavities exist throughout the mass.

If the reader should find himself incapable of coming to any definite conclusion on this question, how much more impossible is it for the student of geology (or mathematics) to settle the difficulty satisfactorily? Each theory initially commends itself with much plausibility to its reader, but as the more important but less apparent tests are applied, certain defects come into prominence.

FISHER'S THEORY.

Fisher succeeded in forming a theory that would comprehend and explain all the difficulties that each previous assumption had encountered.

He accepted the idea of the existence of a liquid substratum, with this difference, that it consisted of a mixture of *fused* rock and a *dissolved gas* (in all probability hydrogen).

The origin of earthquakes and volcanoes can be satisfactorily explained on this assumption, which has the additional qualification of accounting for the appearance of vast quantities of that gas (*i.e.*, hydrogen) in all volcanic outbursts. Furthermore, the fused mass, which Fisher supposes to exist, would not give rise to any tides within the earth's crust, and thus one of the most serious objections to the "liquid substratum hypothesis" (which is itself based on the fundamental notions of the effect of heat on solids) is satisfactorily removed. At the same time the theory admits the possibility that the fused mass *may* communicate its movements to the earth's surface (although not in the form of "tides"), which deduction, taken with all the other scientific explanations, should strongly recommend the theory to all whom it may interest.

Australian Meteorology

UP to the present day, each of the various institutions for studying weather in Australia has been working independently for its own local and particular needs, and there has been no central bureau whose business it has been to gather and discuss this wealth of priceless material, now rapidly accumulating, to advance the knowledge of the meteorology of this portion of the globe as a whole. It is true that valiant attempts have been made by individuals to tackle this inquiry, and, thanks to their efforts, much valuable information has been gleaned.

Australia, as everyone knows, is a very large tract of country, extending considerably in both latitude and longitude. There is undoubtedly a very close connection between Indian and Australian weather, so that a rigorous study of the latter would, in all probability, be extremely useful in helping to unravel the vagaries of the former.

Disastrous droughts are not infrequent in Australia, and at these epochs, when the natural water supply of the country is cut off, millions of sheep die, and in consequence the assets of the country are considerably diminished.

It is therefore of the highest importance for the future welfare of the Australian Continent that, in addition to the various institutions which are at present collecting and publishing meteorological observations, there should be added a central bureau to take a broader view of the situation and co-ordinate and discuss not only the Australian meteorological data *in toto*, but those gleaned from neighbouring islands and seas.

According to recent information there seems a prospect of such a scheme being brought into being, and if it be carried out in a practical manner, the country will undoubtedly be benefited in the course of time. Droughts, of course, cannot be stopped, but their effects may be mitigated by an intelligent use of the knowledge that will be gained by such an institution, after a careful study of the weather changes, changes which have every appearance of being of a periodic nature.

A Successful Flying Machine.

IT is nearly two years (February, 1904) since we announced the successful ascent by Messrs. Wilbur and Orville Wright in an aëroplane of their construction in North Carolina. It seemed at the time as if the accounts might have been exaggerated, and as no further news was heard of these inventors until a few days ago, it was natural to suppose that the apparatus was not quite so perfect as the sanguine makers had at first hoped. Now, however, in a letter which was read at a meeting of the Aeronautical Society on December 15, they make the startling announcement that they have been steadily continuing their experiments, and have been rewarded with highly satisfactory results. No details of the machine itself are given, for the inventors do not wish such to be published at the present stage, but it is presumed to be a motor-propelled aëroplane, entirely dependent for its lifting power on the screw propellers. They state that during September and October last flights were made on eight different days, and that the distances covered during these flights varied from 11 to 24¼ miles. The speed was about 38 miles an hour, and on each occasion the machine returned to its point of departure without suffering the slightest damage. The longest flight lasted no less than 38 min. 3 secs. Such an account may well be received by the general public with some incredulity, but we know the inventors to be thoroughly sound and unassuming men who would not be likely to make such an announcement without very good grounds.

Photography

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Is Development a Reversible Reaction?—It seems that my remarks under this heading in the last number did not make clear, except, perhaps, in a negative sense, what I consider the word *reversible* should mean in its application to development. "Many chemical processes are reciprocating, *i.e.*, the original substances may be re-obtained from the products of the reaction." Such changes are termed reversible. In a purely chemical sense, we may be satisfied with the chemical identity of the original and the reproduced substances, but if development as distinguished from mere chemical reduction is reversible, the original and the reproduced substances must be photographically as well as chemically identical. To be still more explicit I suggest the following experiment:—Let a plate be subjected to a graduated exposure, leaving a part unexposed, and let it be treated as follows in the dark, removing a sample strip at each stage for subsequent critical examination: (1) Develop it. After simple washing (not fixing), (2) treat it with a solution of the products of the complete oxidation of the developer used. This should restore the plate to its condition before development. (3) Treat it a second time with the developer. If development is a reversible reaction the image will again be developed up as at first. The unexposed silver bromide is still present, so that in the second development a definite distinction is made between developable and non-developable silver salt.

If development is a reversible change it may be expected that very interesting results will follow. Perhaps one of the most important of these will be the indication that the change produced by light (that is the difference between developable and non-developable silver salt) is independent of the halogen. The possibility of changing a silver salt that has been made developable by exposure into another silver salt, without losing its developable property, a fact long since known, may be considered as pointing in the same direction. And the case now supposed would go a step further, the halogen being removed entirely and afterwards restored to the metal. Experiments seem to prove that the developable condition does not depend on the medium that supports the silver salt. If the change is in neither the halogen nor the medium, we seem almost driven to the conclusion that it is in the silver. And this reminds us of General Waterhouse's experiments, in which he got the developable condition on a polished silver surface, though I believe he failed when the silver was cleaned by treating it with acid and heating it.

Superposed Stereoscopic Prints.—Those stereoscopic pictures supposed to be made by printing the one member in red and the other in green, the one over the other, and that are viewed by spectacles having a red and a green glass, one for each eye, have generally long bothered me, and, I suppose, other people, by the confusion between stereoscopic and pseudoscopic effects, and, apparently, other confusions, in some parts of them. Mr. Alexander Thurburn, of Keith, Banffshire, in connection with this subject, has recently sent me two stereoscopic diagrams of a pyramid in red and green lines, but in the one the lines are on a white ground and in the other on a black ground. Although the disposition of the coloured lines is the same in both, everyone who looks at them through the coloured spectacles finds the one pyramid to project and the other to recede. By turning the card on a horizontal axis the apexes appear distinctly to move in opposite directions, as they would in the case of a solid and a hollow pyramid. The question was, Is this difference the effect of the difference in the background, and if so, why? I soon found that on the dark ground the lines seen through either coloured glass were those of the same colour as the glass, but on the white ground only the green lines were seen through the red glass and the red lines through the green glass. It is clear, therefore, that as the coloured lines are similarly disposed in the two diagrams the one must appear stereoscopic and the other pseudoscopic. The reason is clear. The red lines seen through the red glass appear white and are, therefore, lost on a white ground but visible on the black. Through the green glass the red lines are apparently black, and, therefore, they show on the white but not on the black ground. The green lines are similarly affected, but in the reverse sense.

In the case of the stereoscopic pictures referred to we have to consider red and green, and the white surface these are printed on. Through the red eye will be seen the green if surrounded by either red or white, and also the red where it is surrounded by green. Through the green eye will be seen the red when surrounded by either green or white, and the green when surrounded by red. As each eye sees, or may see, parts of both the red and the green pictures and cannot see other parts, if each of the stereoscopic pair is printed in a single colour it seems that pseudoscopic and stereoscopic effects must be mixed and confusion result, unless the subject is a very exceptional one. Mr. Thurburn has been good enough to send for my inspection a number of the "Plastische Weltbilder," in which this confusion seemed to him to be absent. I find it is also absent to me. On careful examination I find that the pictures for both eyes are printed in both colours—that is, each eye, using the coloured spectacles, sees parts of both red and green, but not the same parts. The distribution of colour is systematic throughout, and a conspicuous example will show the character of it. A shop front in the foreground has white sash bars in front of a dark interior, and over the front the name is in dark letters on a light ground. The picture provided for the one eye and the picture that is really seen by that eye, has green sash bars and red letters. The picture for the other eye has red sash bars and green letters. The sash bars are light on a dark background, and the letters are dark on a light background. Therefore the representation of objects by such means is not a simple case of printing the one picture in red and the other in green, and discriminating them by means of spectacles with one red and one green eye. This simple and straightforward method must, I think, be faulty, and success appears to depend on a distribution of colour by hand. If it is so, these productions cannot rightly claim to be photographs, and the method is not useful for scientific purposes, as it might otherwise be.

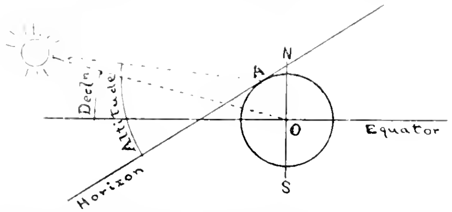
Answers to Correspondents.

Ignoramus. *Altitude of the Sun.* Many books on Practical Astronomy define the terms used, though not in a very explicit manner. Perhaps the following may make it clear to you:— The *altitude* of the sun is the angle at the observer's eye between the sun and the horizon. The *declination* of the sun is the angle between it and the Equator (produced). The declination at noon each day is given in any astronomical ephemeris (*vide* "Science Year Book"). Therefore, knowing the declination, one can find the altitude at any given latitude by subtracting the latitude from 90°, and *adding* the declination if summer, or *subtracting* it if winter (when sun is south of Equator). Thus, if latitude 51° 28′,

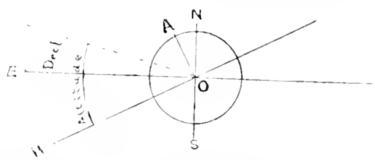
Deducted from 90° = 38° 32′;
Declination at noon January 1st = 23° 3′ 28″;

∴ altitude = 15° 28′ 32″.

The following diagrams explain this, where A is the position



of the observer. Since the sun is at a comparatively infinite distance, the altitude will be practically the same at O (centre of the earth) as at A. Then in fig. 2, N O E is a right angle, as is A O H. Deducting the common angle A O E (= the



latitude), we have N O A (= 90° − latitude) = E O H, and E O H + Declination is the altitude. This, of course, is the principle for finding one's latitude at sea. *Observe* (with a sextant) the altitude of the sun above the horizon, add or deduct the declination (as given in tables), and deduct the result from 90°. This gives the latitude.

Cecil Evans. Though we have referred your letter to several authorities, we fear it is not sufficiently explanatory for us to comprehend your meaning.

G. P. Blake. Remember that the obliquity is not constant. It is diminishing *about* 0″·4 annually, though the *exact* diminution can only be surmised by theory. The change should not be "put down to precession."

To Make Iron Grow.

THE Franklin Institute has awarded the Elliot Cresson Gold Medal for a new process by which iron can be made to grow. This consists in heating and cooling the bar of iron which it is intended to magnify to a "critical" temperature a number of times. The results are extraordinary. To the Mechanical Science Section of the American Association two bars of iron cast in one mould were presented for critical inspection. One bar remained exactly as cast. The companion bar had been caused to grow gradually in cubical dimensions till it is now 40 per cent. larger than the other, the weight remaining the same as before expansion. Both bars were machined on one side to show the texture and metallic appearance; and it was difficult to detect any change except the very apparent difference in size. It is said that important practical applications have already been found for this remarkable discovery.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Diffraction Grating Replicas.

FOR some years past both physicists and astronomers have been using the excellent Diffraction Grating Replicas made by Mr. T. Thorp, of Manchester, and now he is able to make the interesting announcement that he has been successful in producing *concave* replicas. There will be a very great field for the application of this form of spectroscope, which is self-contained and needs neither collimating nor telescope lenses. At present the replicas are only of plain celluloid, but experiments are in progress for silvering the diffracting surface, when the brightness of the spectra will be greatly enhanced.

Another distinct advance is the making of the grating films on glass rings, so that there is no glass for the light to pass through, and these will be very useful for investigations of ultra violet radiations.

Possible Relationship between Light and Velocity Variations of Variable Stars.

In a recent paper by R. C. Curtiss the author points out an important coincidence which he has found to exist between the variations of magnitude and radial velocity of the variable star W Sagittarii. When these were plotted it was at once seen that there was a most striking concordance, the two curves corresponding not only in general form, but in most of the minor inflections. The *light maximum*, according to the latest values, occurs 0·99 day after periastron, and almost exactly at the epoch of *velocity minimum*. Comparing the most recent photometric measures of the light variation, from the Harvard College Observatory, with those made by Schmidt some thirty years previously, there are seen to be numerous differences, and it seems not improbable that these may be more or less due to actual changes in the system of this star during the interval which has elapsed between the two series of observations.

New Views about Comets.

Various novel facts concerning the formation and appearance of the tails of comets have recently been described by Professor Barnard, the discussion of which leads him to think that the views generally accepted may have to be considerably modified in future.

Although no explanation has been definitely found to cover all the many details exhibited by the growth and dissipation of a comet's tail, that of Bredechin has probably received most favour. This ascribes the varying forms of tail to different constitution of the matter evolved from the comet, on which the resulting effects of the sun's repulsive force will be to produce streams of cometary matter extending in curves of varying degree, depending on the density or other physical properties of the substance. In this and most other theories it has been customary, however, to ascribe practically all the cause of the phenomena to the action of the sun, supposing the comet to merely supply the material to be acted upon.

During the last ten or twelve years, however, the application of photography has resulted in the discovery of many new features which are rather of a revolutionary nature, and are not easily explained. Professor Barnard now thinks that three main causes are at work.

First, the sun, which produces in the nucleus of the comet a disturbing action, and which influences the general direction of the tail-producing particles. Second, the comet itself, in which a strong ejective power seems to be located. This is proved by the frequent formation of straight minor tails or streams of particles which are often seen to issue at large angles to the general direction of the main tail. Such peculiarities are quite contrary to the effect produced by the sun. In many cases it would seem that this emissive power is great enough to entirely overcome the direct pressure of the sun's light. Not only this, but the sun's light appears to have no bending effect towards the radius vector, as might be expected. Third, an outside influence quite apart from the comet, which is shown by the many rapid distortions and deflections of the tail. There appears to be clear evidence that this is some sort of resistance offered by a kind of medium not uniformly distributed in the planetary spaces, as, for instance, a meteor swarm. Encounters with such a medium would readily explain the sudden brightening up of some comets when long past their theoretical maxima, as was shown by Sawerthal's comet in May, 1888, or it might account for the breaking up of such a comet as Biele's. It would seem that something of this nature was chiefly instrumental in producing the special peculiarities of the tail of Brook's comet in October and November, 1893. Photographs taken by Barnard on November 2 and 3 show most remarkable changes, and these are strikingly shown in a composite picture made by superposing the two plates star for star, giving the two positions of the comet with 24 hours' interval. There is a difference of nearly 15 between the directions of the tail in the two cases, while it is remarkable that the position of the ends of the tails do not appear to have materially changed, and various portions are seen to be detached from the main stream.

Basing on these evidences of quick change a suggestion that every active comet should be photographed as often as possible, he points out that this might with advantage be done hour by hour during every night, as by this means the actual changes in any part of the cometary matter might be followed with certainty, and it may be possible to determine the exact value of the motions of the particles in the tails of various comets, or the same comet, at different distances from the sun, and so give the true law of the velocities of these particles apart from any theory. It seems then more likely that the different tails of a comet are all made up of the same kind of particles, and the cause of their different directions is that they are ejected towards different parts of space by a force residing in the comet itself. The evidence of the spectroscope, so far as it goes, has certainly not shown them to be of very diverse elements.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

Acetylene Black.

The old method of obtaining a black pigment for printing ink was to conduct the smoke from burning wood, oil, or resinous substances into a cylindrical chamber in which were hung sheep skins or sacking. An inverted iron cone was suspended from the top of the chamber, which it fitted so exactly that when lowered its edges scraped the suspended sacking and removed the black deposit. There are numerous other methods based on the same principle, such as, for instance, that claimed in a recent U.S.A. patent, in which several oil lamps are burnt beneath a hollow cylinder through which passes a current of cold water, the deposit of lampblack being removed by a fixed brush as the cylinder revolves. However carefully prepared, lampblack invariably contains more or less tarry oil, which being yellow detracts from the depth of tone, and the usual method of removing this is to calcine the black in closed iron boxes with only a small opening for the escape of impurities, every precaution being taken to prevent the admission of air. The discovery of natural gas in various parts of the United States put a cheap source of black at the disposal of the maker of printing ink, and led to the American inks acquiring a high reputation for depth and richness of tone. The gas issues from borings 2000 feet in depth, and is burned in jets beneath revolving iron rings, on the surface of which the black is deposited, about 1000 cubic feet of gas being consumed in the production of 1 lb. of gas-black. The product is much purer than ordinary lampblack, and in the crude state contains 92 to 93 per cent. of carbon, 5 to 6 per cent. of oxygen, 1 to 2 per cent. of hydrogen, and traces of mineral matter. Its tinctorial power is also much higher, and it requires less purification than lampblack. A still purer and more intense black has recently been prepared by Dr. Frank by exploding a mixture of acetylene with carbon monoxide or dioxide, and it is claimed that this product is superior to the best American gas-blacks both in quality and covering power. On the other hand, its cost is likely to be greater than the American blacks, which at the present time fetch about 3d. or 4d. a pound.

Water from the Simplon Tunnel.

In the course of the construction of the Simplon Tunnel numerous springs were encountered, and the water from one of these, about five miles from the Italian end of the tunnel, has been analysed by Mr. A. G. Levy. The water, which had a temperature of 113 F. at the point of collection, was clear, colourless, and without smell, but had a saline taste. It contained 106·5 grains of solid matter per gallon (about five times that of London drinking water), consisting principally of calcium sulphate, with a considerable proportion of magnesium sulphate, and small amounts of other salts. It was quite free from organic matter and also from chlorine, which latter fact was the remarkable characteristic of the water; since, considering the distance it must have travelled underground to attain its high temperature, one would have expected it to come in contact with soluble chlorides somewhere on its way.

Photo-Active Properties of Rabbits' Blood.

Experiments have been made by Dr. V. Schlapfer, of the Pathological Institute of Zurich, to determine whether blood is capable of affecting a photographic plate in the dark. For this purpose the fresh blood of albinotic and pigmented rabbits was employed, with and without previous exposure to light, and also after treatment with prussic acid and potassium chlorate. In each case the plate was covered with black paper, on which was placed a photo-neutral capsule of paraffin wax containing the blood. It was found that the blood of pigmented rabbits had a very much weaker effect upon the plate than that of albinotic animals. The activity of both disappeared after some days, but could be restored again by exposure to light. Blood treated with prussic acid was invariably inactive, whereas that of animals poisoned with potassium chlorate was always active. The stimulative influence of light upon the photo-activity of the blood has suggested to Dr. Schlapfer a theory to account for the marked difference in the behaviour of the blood from the pigmented and the albinotic rabbits. He considers it possible that in the case of the albino the blood circulating in the cutis may be acted upon to a considerable extent by the light and thus rendered photo-active, whereas the pigments in the skin of the brown rabbit may act as a light-screen and weaken the effect of the rays.

GEOLOGICAL.

By Edward A. Martin, F.G.S.

A Twin-Earthquake.

Dr. Charles Davison keeps unceasing watch over the various earthquake shocks which are constantly visiting our islands, more frequently perhaps than most people believe. In a recent paper he has described the Doncaster earthquake of April of this year. He tells us that it was a twin-earthquake, with its principal epicentre half-a-mile north of Bawtry, and the other about four miles east of Crowle, close to the centre of the Hessle disturbance of April, 1902. Last April the earthquake-area included about 17,000 square miles. He says that a twin-earthquake is probably due to the differential growth of a crust-fold along a fault which intersects it transversely, the first movement as a rule being one of rotation of the middle limb, accompanied by the almost simultaneous slip of the two arches, and followed soon afterwards by a slip of the middle limb.

The Scuirr of Eigg.

At a meeting of the Geological Society held on December 6, Mr. Alfred Harker read a paper on "The Geological Structure of the Sgùrr of Eigg." The mention of this phenomenal mass of pitchstone naturally recalls to mind the very full description which we have had from Sir Archibald Geikie of the island, and the deductions which he has drawn as to the remarkable changes of level which have taken place, and the vast amount of denudation which has resulted in the formation of the Scuir (so spelt by Sir Archibald). The pitchstone is a massive sheet some 400 feet thick, and reposes upon alternating basalts and dolerites, which make up the greater part of the island. Beneath the pitchstone there are in two places accumulations made up of fragmentary materials, and these the latter geologist regarded as river-gravels of the age of the pitchstone, which overflowed into the valley of a stream which has since disappeared. The fragments of the gravel have alone been preserved by the pitchstone protecting it from denudation. Mr. Harker is unable to accept Sir Archibald Geikie's view. He thinks that the pitchstone may have been intrusive, and does not think that its base is reconcileable with that of a river valley. The fragmentary deposit is in one place, he states, a volcanic agglomerate, probably filling a small vent, and the other appears to him as a bedded agglomerate, but this he admits has been re-arranged by water action. There are contained in the deposits abundant blocks of Torridonian and Oolitic sandstone, with fossil wood of Oolitic age, and these are held to have been forced up from below. In this respect there is perhaps some failure of evidence, and some geologists will not regard this explanation as a probable one. It should be added that Sir Archibald adheres to his own explanation of the origin of the fragmentary deposits, and no doubt more will be heard of the matter now that the leading geologists differ radically as to its origin.

Pleistocene Lake at the Mouth of the Tagus.

At the same meeting a paper was read by Prof. Edward Hull concerning the "Great Pleistocene Lake of Portugal." The margin of the former lake was probably formed by the granite of Das Vargans and Cunheira. Miocene times are thought to be represented by the Almada Beds, and the Pliocene not being represented, except possibly by certain glacial deposits. Prof. Hull thinks that the period was one of great uplift, and this resulted in the excavation of the sub-oceanic gorge which marks the seaward extension of the River Tagus. Thus the lake was finally drained by the Tagus cutting a channel at the harbour of Lisbon, upon the elevation of the land to about its present level.

Glaciation in Snowdonia.

Evidence of the Glacial Epoch are numerous in North Wales, as all acquainted with Snowdonia are well aware. Our

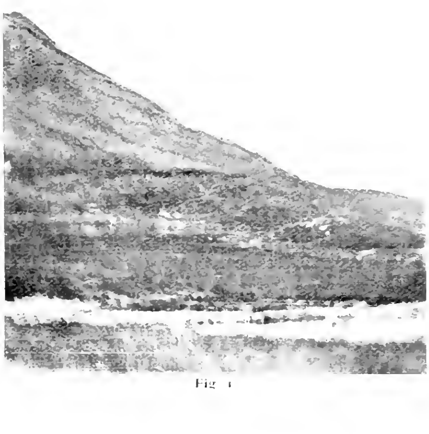


Fig. 1

illustrations give two well-marked types of scenery. Fig. 1 shows a fine series of moraine hillocks near the Devil's

Fig. 2

Kitchen, at the head of Nant Ffrancon valley; and fig. 2 gives the *roches moutonnées* appearance of surface-rock resulting from the planing power of a mass of moving ice, taken from the same neighbourhood.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Humming Birds in England.

At the meeting of the Zoological Society on November 28, Captain Pam gave a most interesting account of his attempt to start a colony of humming birds at the gardens of the Society, and, though this attempt was frustrated, the greatest credit is due to Captain Pam for the strenuous effort he made to achieve this end. He left Venezuela with about half-a-dozen specimens of *Petasophora iolata*, the Bolivian "violet ears" of Gould's monograph of these birds; but, unfortunately, only one reached the gardens alive, and this has since died. He fed his birds on a mixture of sugar and meat extract, a diet which seems extremely well suited for these delicate birds, inasmuch as he succeeded in keeping his captives alive, and well, longer than many residents in Venezuela who have continually endeavoured to keep these birds in aviaries, but without success—two months being about the record.

Humming birds appear to be late feeders, coming out just when other birds are going to roost. They are also heavy sleepers; so much so that Captain Pam found it difficult to awaken his birds after they had finally retired to roost. They appear to be extraordinarily sensitive to shock, so much so that should the cage in which they are confined receive a sudden jar, they lose their foothold—for the feet are remarkably small, and but little used—and tumble to the bottom of the cage. Whenever this happens, it results in a total loss of the power of movement in the wings; the birds become unable to regain the perches, and speedily die.

It was believed that this bird was the first humming bird ever brought into this country alive. But Mr. Pocock points out (*Field*, December 9) that in July, 1894, no less than eleven specimens of *Trochilus* [illegible] were brought over in the s.s. *Nile*, and were ultimately purchased by the late Mr. Erskine Allen, of Gray's Inn. It would be interesting to have further particulars of these birds.

The Breeding Plumage of Birds.

In a very short but extremely interesting article in the *Field*, December 2, signed "R. L.," a new interpretation is given to the "eclipse" plumage of the Mallard and other Anatidæ. It is suggested that the "eclipse" dress corresponds to the non-breeding plumage of, say, the Waders, while the brilliant livery worn during the greater part of the year really answers to the breeding dress of the Waders, which is worn for a short period only. But for the need of protection during the period of quill-moulting it is contended the Mallard would have assumed a permanent breeding dress, as in the case of the Sheldrake, or of the game-birds for example.

Whenever the male birds are brilliantly coloured we may assume, he points out, that this is a permanent breeding dress, and when the hen stands in no need of a dull protective dress she also assumes a similar plumage.

With this interpretation we heartily agree.

A New British Thrush.

The *Field*, December 2, contains an account by Mr. T. Whittaker of the occurrence of the Dusky Thrush (*Turdus dubius*) in Nottinghamshire. The bird was shot near Gunthorpe, and is described as having a flight like that of a jay, and a note like that of the fieldfare. This bird is a rare straggler to Europe, having occurred but twice in Norway, once in Germany, once in Belgium, and four times in Italy.

Leach's Petrel in Berkshire.

We learn from Messrs. Rowland Ward and Co. that they have recently received a specimen of Leach's petrel in fine condition, which had been obtained during the last week in November at Caversham, having probably been driven inland by the late strong westerly winds. It proved to be a male, on dissection.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Wireless Telegraphy.

IN the *Annalen der Physik*, J. S. Sachs describes experiments which throw some light on the part which the earth itself plays in wireless telegraphy. He concludes that transmission is better the higher one is above the ground, and thence that the earth is detrimental to the propagation of electric waves.

Motors and Dust.

Mr. W. R. Cooper has recently described experiments carried out on a flour-covered track with a tricycle hauled along at various speeds. A slack tyre is shown to raise more dust than one pumped tight. A square box carried at different heights above the ground raises less dust the higher it is above the ground; very little is raised when the box is inclined so as to throw the air down.

Phosphorescence and Stokes' Law.

Professors Nichols and Merritt, in the *Physical Review* for October, describe experiments bearing on the phosphorescence of Sidot blende (zinc sulphide) under various exciting causes. Amongst other results they show that when the exciting light is limited to a range of wave length from ·470 to ·497μ, the luminescence observed after the exciting light is cut off extends to wave lengths in the violet certainly beyond ·40μ. There thus appears to be the same violation of Stokes' law which they have previously found to occur in the case of fluorescence. In explanation of this statement we may point out that, according to the law enunciated by Stokes, the excited light must always be of longer wave length than that which excites it. It would seem that under ordinary circumstances this law must be true whenever the radiation depends merely upon temperature, as, for example, when dark heat is focussed upon a platinum black surface and makes it white hot. On the other hand, it has been shown that even in such a case the result is due merely to the fact that the region of maximum energy of the spectrum is situated for the hottest known bodies in the infra red. If temperatures were attainable so high that the maximum shifted into the ultra violet, the opposite to Stokes' law should be expected to hold.

When, however, the luminescence is not due merely to the temperature—and such is the case for all kinds of phosphorescence and fluorescence—there is no reason known why Stokes' law should hold, and [illegible] therefore to find that it is not valid. It [illegible] over, to point out that it has recently [illegible] himself threw doubt upon it in his later correspondence.

Refractivity of Fluorine.

Messrs. Cuthbertson and Prideaux have succeeded [illegible] mining the refractive index of Fluorine. Special interest was felt in regard to this question because of the relations which Cuthbertson had previously shown to exist between the refractivities of the elements. Taking the non-valent column of elements as arranged in a periodic system of the elements, he showed that their refractivities were in the following ratios:—

He	Ne	Ar.	Kr	Xenon
½	1	4	6	10 ;

he further, by obtaining data for other elements, proved that these numbers appeared to be characteristic of the particular rows in the Periodic Table to which these elements respectively belong. Thus the value for sulphur (which lies in the same row as Argon) is four times that for Oxygen (which lies in the same row as Neon). Chlorine and Bromine and Iodine have numbers in the ratio of 4, 6 and 10. Now Fluorine heads the column in which these numbers lie, and in order to prove the generality of Cuthbertson's relations it was necessary to find the value of Fluorine. As the result of a very difficult investigation carried forward with great zest by these investigators it turns out that this element also conforms to the rule. As experiments on other substances are proceeding we may hope shortly to be able to classify other elements either as conforming to this rule or to some more general one of which it is a special case. Unfortunately the refractivities of compounds, of which many are known do not supply much information on this question, because the refractivities of compounds are not the algebraic sum of the refractivities of their constituent atoms, although in most cases this additive law is approximated to within perhaps twenty per cent. We hope to return to this matter before long in order to indicate the physical cause of these simple relations between the refractivities of the elements.

ZOOLOGICAL.

By R. LYDEKKER.

Colour Change in Gibbons.

How imperfect is still our knowledge of the life-history of many animals has been remarkably illustrated of late by a gibbon from the Island of Hainan which has for some time been living in the Zoological Society's Garden. When received, and apparently full grown, it was jet black all over; after a time, however, it changed its coat, when, to the astonishment of everybody, it came out in a greyish buff livery, the bare skin of the face alone retaining the original sable hue. Probably certain allied species of gibbons undergo a similar colour-change with age, although the Himalayan [illegible] and the Sumatran siamang are apparently always black.

Variation in Lizards.

A very remarkable paper on the pattern and colour variation displayed by different phases of the wall lizard of southern Europe has recently been published in the *Transactions* of the Zoological Society. How great are the variations in these respects, a glance at the beautiful series of plates with which the paper is illustrated will serve to show. By some authorities these variations have been—and probably still are—considered as of specific importance; and it is from the boldness with which the author, Mr. G. A. Boulenger, sweeps away such nominal distinctions that we have ventured to call the paper remarkable in these days of incessant splitting of species and races. "Of late," writes the author, "a tendency has sprung up to greatly multiply the species and thus destroy the old conception of *Lacerta muralis*. I doubt whether such attempts will conduce to a better understanding of the subject. . . . Characters of form and coloration are given as distinctive which, on examination of even moderately large series of specimens prove to be worthless, while others of greater importance have been overlooked or neglected." Evidently much water has still to run through the bridges before our conception of what constitutes a species, or even a race, can be regarded as finally settled.

The Senses of Animals.

Several interesting communications have appeared during the last few weeks concerning the senses and psychology of animals. A German authority has, for example, expressed the opinion in somewhat confident terms that fishes are stone-deaf; this view being based on the structure of their internal ear. A discussion on the subject has appeared in the columns of the *Field* newspaper, in which several anglers point out that fishes can perceive vibrations, from which it is inferred that they can hear. This is, of course, begging the question, as if the German aurist is right in his contention that fishes lack the essential parts of the organ of hearing, it is quite evident that vibrations must be perceived in some other manner. A second Continental authority has adduced evidence to show that ants recognize one another by means of the sense of smell, which is apparently located at the base of their antennae. Finally, a third foreign naturalist, who writes from Costa Rica, is of opinion that there is no difference in kind between the essentially automatic actions of even the lowest organisms and the manifestations of the human will, but that there is a gradual transition from one to the other.

New Bats.

The study of bats has occupied a large amount of attention during the last few months, and a number of new species and races of the horseshoe and leaf-nosed groups have been named. By far the most interesting addition to the list is, however, a new mastiff bat from West Africa, since it is a near relative of a group hitherto known only from tropical America. It comes, indeed, very close to the American *Molossus*, although it has been made the type of a new genus—*Lomops*.

Papers Read.

At the first meeting for the 1905-6 session of the Zoological Society, held on November 14, Dr. Kidd discussed the arrangement of the fine ridges on the hands and feet of various species of mammals, chiefly monkeys and lemurs. Mr. Bonhote named two new species, and one race of Tibetan mammals, viz., a fox, a hamster, and a vole. Major Evans communicated notes on the gorals, or lesser goat-antelopes, of Burma; while Miss Bate gave an account of the mammals of Crete. At the meeting on November 28 Mr. Lydekker discussed the colouring of the guereza monkeys, and also called attention to a mounted specimen of the little known white-maned serow, or goat-antelope of China; Mr. Thomas exhibited and discussed a collection of mammals from Japan; and Mr. Regan proposed a rearrangement of the fishes of the southern family *Galaxiidae*. At the meeting of the Geological Society held on November 22 Dr. Smith Woodward described new remains of a species of an extinct genus of Chimæra-like fishes from the Lias of Lyme-Regis.

REVIEWS OF BOOKS.

My Life: A Record of Events and Opinions, by Alfred Russel Wallace; in two vols. (Chapman and Hall; price, 25s. net.).—Among the many claims to attention possessed by Dr. A. R. Wallace's autobiography is that of furnishing a summary of most of the controversies which shook the mid-Victorian era. It was the day of controversies and of controversialists, perhaps because it was also the day of great generalisations; perhaps because scientific interests were less decentralised, and what interested one body of scientific workers interested them all. The controversies of to-day between Sir Oliver Lodge and Professor Ray Lankester and Mr. Mallock on Psychics, or between Mr. Bateson and Professor Karl Pearson on Heredity, rouse no such passions as those between the Darwinians and the theologians, or between Dr. Wallace (for example) and St. George Mivart and the other sceptics of Spiritualism. To read Dr. Wallace's record of these great controversies is to experience a sense of intimacy with another generation, as well as with other times. Dr. Wallace is the last of the great controversialists. He was one of the three who "kept the bridge" for Darwinism; but a controversy even of that embracing kind was not enough to absorb all his energies. Land nationalisation, Socialism, Spiritualism, and a fierce dispute with a fanatic about the configuration of the Earth were some of the subjects on which he argued, wrote, and spoke; and it is significant of the energy which he put into all that he did that the last named of these controversies—settled by the famous Bedford Level experiments—gave him more trouble and took up more of his time than any of the rest. The details, the correspondence, and the stages of these controversies are all related with great fulness in the two volumes of Wallace's "Life," and would be of the greatest interest and value even had he himself played a less prominent part in them. His position, however, with regard to them is of the first importance. To many people in this degenerate day he is chiefly remembered as the associate of Darwin in what people are sometimes pleased to regard as the "discovery" of the Darwinian theory. A theory of this kind is never "discovered"; it must be the outcome of the most patient and long-continued examination, observation, and confirmation of research. If it were otherwise, then Democritus or some of the early Greek philosophers who speculated on the origin of the universe might be claimed as the "discoverers" of Dalton's Atomic Theory, or of the Fourth State of Matter postulated by Sir William Crookes, and elaborated as a theory of Professors J. J. Thomson and Rutherford. In such a sense Dr. Wallace might—with much more justice—claim to be the discoverer of the Darwinian doctrine of the origin of species, for the idea came to him as a brilliant flash of inspiration while he was in the Malay Archipelago examining and classifying some of his zoological captures. "At the time in question," writes Dr. Wallace, "I was suffering from a sharp attack of intermittent fever, and every day during the cold and hot fit had to lie down for several hours, during which time I had nothing to do but to think over any subject that particularly interested me. One day something brought to my mind Malthus's 'Principles of Population,' which I had read about twelve years before. I thought of his clear exposition of the 'Positive checks to increase'—diseases, accidents, war, and famine—which keep down the population of savage races to so much lower an average than that of more civilised peoples. It then occurred to me that these causes and their equivalents are continually acting in the case of animals also. . . . Vaguely thinking over the enormous and constant destruction thus involved, it occurred to me to ask the question 'Why do some die and some live?' And the answer was clearly, 'that on the whole the best fitted live.' . . . Then it suddenly flashed on me that this self-acting process would necessarily *improve the race*, because in each generation the inferior would be killed off and the superior would remain, that is, *the fittest would survive*." The idea, thus furnishing one of the curious coincidences of science, occurred to Wallace while Darwin was working at it; but it is none the less to Darwin that the establishment of the great principle on a firm basis is due; and it is to him, as Dr. Wallace modestly admits, that we must ascribe the name of the real discoverer. In this extract we have touched upon only one facet of interest among the many for which these remarkable volumes are conspicuous. They were written by a man who was intimate with the best scientific intellect of two generations, and who has been generous in relating the points of contact he had with them.

An Elementary Text-Book of Inorganic Chemistry, by R. Lloyd Whiteley, F.I.C.; pp. 8 and 245 (Methuen; price, 2s. 6d.).—Students taking the elementary stage of the Board of Education examinations in inorganic chemistry will find all they require in this little book, which is too short, however, to include much more than the details essential for this particular purpose. It is well printed and illustrated, and gives descriptions of numerous experiments in such a way that students can repeat them for themselves.

Radioactivity, Professor Rutherford (Camb. Univ. Press, 10s. 6d. net).—The appearance of a second edition of this treatise so soon after the appearance of the first is an event which gives rise to an apology from the author to the purchasers of the first edition. However, so rapid and extensive have been the advances made in our knowledge of the subject, that everyone will concede that no apology is due. The present edition is to all intents a new book, although it is based upon the old one. Besides a rearrangement of the whole, three new chapters have been added, which give a detailed account of the theory of successive changes and of its application to the analysis of the series of transformations which occur in radium, thorium, and actinium. The disintegration theory, about which there was much misgiving in many minds, still holds its ground as the most effective of all theories in co-ordinating the multitudinous experimental data which are known, and as providing a most powerful and valuable method of analysing the connection between the series of substances which arise from the transformation of the radio-elements. Many of the results of the researches during the past year have already been noted in this Journal; and it will be recalled that for these results Professor Rutherford is himself largely responsible. From the beginning, when facts were few and theories conflicting, he seems to have been marked out as the man possessing just those qualifications required in a pioneer investigator—viz., fertility of resources, and an adequate endowment of what many would call crudeness, which enables a man to go for and seize the main outlines of a subject while others are groping in the dark after irrelevant minutiæ. The result is a magnificent achievement; and everyone will welcome this fresh summarisation of the present state of knowledge by one from whom so much of it has come. We cordially commend this book both to the expert, to whom the possession of it is a necessity, and to the amateur reader or speculator, who, if not already acquainted with it, will be surprised at the ease with which it will enable him to enter into a real knowledge of this fascinating subject.

Instruction in Photography, by Sir William Abney (Iliffe and Sons; price 7s. 6d. net).—The fact of an eleventh edition of a book being published is in itself a complete proof of the value and usefulness of the work. Abney's "Instruction" has before now been aptly termed "a photographic classic," and contains all that an amateur, or professional either, should know. We should not like to go quite so far as to say that what is not in this book is not worth knowing, but it is safe to say that any matter omitted is beyond the scope of the ordinary photographer. Both the theory and the practice of this subject, which is now becoming so greatly enlarged, are carefully gone into. Besides considerations of the action of light on silver compounds, the development of the resultant image, the theory of lenses and stops, the preparation of gelatine and other emulsions, we have information on transparencies, enlargements, and copying. There are descriptions of the various modes of printing and preparing sensitive papers, as well as such more elaborate processes as photo blocks and three-colour printing, which latter especially has been considerably enlarged in this latest edition.

British Rainfall, 1904, compiled by Hugh Robert Mill, D.Sc., &c. (Edward Stanford; price 10s.). This annual, so indispensable to all meteorologists, is a most complete collection of statistics relating to rain. Part I. contains a report touching on the work of "The Rainfall Organisation" that is, the organisation for observing and recording rainfall; original articles on the rainfall on Ben Nevis; the driest October on record; and twenty-four years' records. Tables are given of the duration, &c., of rainfall; and accounts of the staff of observers, &c. Part II. deals exclusively with 1904, with discussions on the special characteristics of the year. The book is well got up, and contains a number of excellent maps and charts.

The System of the Stars, by Agnes M. Clerke. Second edition (A. and C. Black; price 20s. net). It is already fifteen years since the first edition of this work appeared, and, as a result of the progress which the science of astronomy has undergone during that period, very extensive additions and corrections have become necessary. Among other features a number of excellent reproductions of photographs are now included, which add greatly to the interest of the book. Astronomers, and especially amateur astronomers, will welcome this up-to-date account of the stellar universe, resting assured that the information given is accurate and complete, as well as the style and wording being attractive. As the author remarks in the preface, "literary treatment is the foe of specialisation," and that literary treatment which renders clear and inviting the mysteries so often hidden beneath a load of abstruse phraseology is to be encouraged. We would advise those ordering the book to insist on the pages being cut before delivery.

Quiet Hours with Nature, by Mrs. Brightwen (London: Fisher Unwin).—This little book is probably one of the best that Mrs. Brightwen has written. Herein she discourses on many subjects—beasts, birds, and beetles, trees and gardens. Wide as is the range of these pages, yet nowhere are they dull; on the contrary, there is a sparkle in them that is refreshing, especially when one recalls the twaddle and crude inaccuracies that pass nowadays for "nature-study," and find favour with those who are supposed to possess a nice discrimination in the choice of books for the young. This volume is one which we hope will be largely read. The photographs from nature are charming, but many of the original drawings are, to say the least, unsatisfactory.

Wild Wings, by Herbert K. Job (London: Constable and Co.; 1905). This book is unquestionably a valuable contribution to ornithological literature. Though entirely concerned with the ways of wild birds, many of which have been tracked to their inner fastnesses, it contains many facts that will throw light on the deeper problems of evolution and systematic ornithology. The author displays not only a wide knowledge of his subject but a rare discrimination in the selection of his facts, a combination which is all too rarely met with in the books of recent writers on this subject. Artists should find this book a boon, for the illustrations, which are numerous, may be described in many cases as superb, while their general average is far above that which we are accustomed to meet with. W. P. P.

Trees, by H. Marshall Ward, Sc.D., F.R.S., &c.; Vol. III., Flowers and Inflorescences (Cambridge: The University Press; 1905).—If the series of volumes on trees which Dr. Marshall Ward has set himself to write do not exactly furnish exciting or fascinating reading they will prove a very present help in time of trouble. This volume, like its predecessors, is in every way admirable. To the working botanist it will prove an indispensable companion, while to those who are desirous of taking up this study we cannot recommend a better book. To these last, probably this book would appear on a casual examination too technical, but a very slight acquaintance with its contents will show not only that this impression is quite erroneous, but that here, as in few other similar volumes, they will find a key to mysteries and delights which they had probably never suspected. The author calls special attention to a feature of this volume which should prove of value to the forest botanist. This is a supplementary table of classification, by means of which that most difficult of groups—the willows—may be distinguished by characters derivable from staminate or from pistallate flowers respectively. The illustrations which are profusely distributed throughout its pages are extremely well chosen, and many are of great beauty.

We have received from Messrs. Newton and Co. their latest catalogue of Optical Lanterns and Slides. This includes a marvellous collection of views of all sorts and kinds, but we would especially notice the complete series in astronomical and in physical subjects.

Another novelty has recently been introduced by the firm and may be seen at their establishment in Fleet Street. It is called the "Sympathetic Pendulums," and consists of two weights suspended by springs from a bar of wood. When one weight is pulled down and released, it vibrates up and down for a certain time, but then seems to impart its motion to the other weight which starts bobbing up and down, while the first rests perfectly still. But in due course the second weight comes to rest and the first again starts its motion.

We have received, among others, an interesting catalogue of **Meteorological Instruments** from Messrs. Pastorelli and Rapkin, with equipment sets for meteorological observations. Also one from Messrs. Darton and Co. on **Electrical Novelties**, many of which form suitable presents for this season of the year. Several new **Electrical Instruments** are described in a set of leaflets issued by the Cambridge Scientific Instrument Company, Limited, and Messrs. Taylor, Taylor, and Hobson send a new list of their **Cooke Lenses** which is worth perusal by photographers.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 308.)

THE room should now be darkened and a piece of white paper held in the beam of light coming from the bull's-eye. By moving this backwards and forwards an approximate position can be found where the light comes to a focus, and by slightly moving the bull's-eye itself this focus will be found to lengthen and shorten inversely as the corresponding conjugate focus from the lamp-flame lengthens and shortens. When the bull's-eye is adjusted to give parallel light the disc of light upon the paper should be of the same size as the bull's-eye, and should remain of the same size, neither more nor less, whether the paper be brought towards the illuminant or receded, and when looked through directly, the bull's-eye should be full of light at all distances. Unfortunately, the ordinary bull's-eye has so many aberrations inherent to its simple form of construction that only approximately parallel light and only approximately focussed light can be obtained by its means. The ordinary so-called "aplanatic" bull's-eyes are only a degree better, and it is here that the advantage of a really well-corrected condenser such as that of Mr. Conrady (see "KNOWLEDGE" for June, 1905, page 138) becomes evident. A word may be said concerning the large condensers, six inches or so in diameter, found on some Continental photo-micrographic stands. They, of course, take in a large amount of light, but they take in more, as Mr. Conrady says, than the objective can utilise, and, in addition, they generally consist merely of a couple of simple uncorrected plano-convex lenses. The second method of adjusting the condenser is to throw parallel or approximately parallel light upon the sub-stage condenser direct, and with an ordinary bull's-eye this gives as good or even better results than the method of focussing 10 inches behind the condenser just mentioned. Of course, were the light really parallel, the sub-stage condenser would bring it to a focus upon the object once more, but this does not happen in practice. The third method is to project the light into the plane of the objective itself, and this is generally done with low powers, especially those planar lenses of three inches or more focus, which are used for low power work. By this means the whole field can be uniformly illuminated.

But we now come to the most important adjustment of all, namely, the due centring of all the optical appliances mentioned, and it is here that the worker will feel the full advantage of those means of vertical and horizontal adjustment for each piece of apparatus mentioned previously. First set up the microscope horizontally so that the eye-piece end is connected with the camera, and make the light-tight connection. Place the illuminant a foot or more beyond the sub-stage so as to shine through the tube. Then screw in a low power objective and examine the disc of light upon the ground-glass screen of the camera.

(*To be continued.*)

Royal Microscopical Society.

November 15, at 20, Hanover Square, G. C. Karop, Esq., M.R.C.S., vice-president in the chair. The Curator explained the Lucernal and Solar microscopes by Adams, presented to the Society that evening by Mr. Wynne E. Baxter. They were described by the maker in the "Essays on the Microscope," published by him in 1787. Dr. Hebb exhibited a magnifier made by Messrs. Taylor, Taylor and Hobson, of Berners Street, and Leicester. It was intended for focussing in photo-micrography, being placed against the ground-glass screen, and was provided with an adjustable draw-tube and a screw ring to clamp the same. Dr. Hebb also exhibited a turn-table, the joint invention of Mr. A. Flatters and Mr. Wm. Bradley. It was driven by clock-work and designed for turning oval cells and ringing oval mounts from any size up to 3 by $1\frac{1}{4}$ inches. By means of this turn-table, it was also possible to run a ring around a needle point, to turn circles, or to strike a straight line. An additional chuck, by means of which square covers also could be sealed, was not satisfactory in performance. The Chairman, whilst remarking on the ingenuity of the instrument, observed that it was doubtful if anyone present at the meeting would have occasion to mount objects in such numbers as to need so elaborate an apparatus. Mr. R. W. Paul sent for exhibition a Nernst lamp, for use with the microscope and for enlarging photographs, but was unfortunately unable to be present to explain its advantages. Mr. F. W. Watson-Baker exhibited a series of dissections of the Tsetse fly and its Trypanosomes, from South Africa, also a specimen of the larva of Ochromyia, together with the perfect insect. The larva also comes from South Africa and lives in the sandy earth, attaching itself to the flesh of natives and causing troublesome wounds. There was also a specimen of the ova of *Schistosoma Sinensis*, found in the body of a Chinaman, who died at Singapore.

The Quekett Microscopical Club.

The 425th ordinary meeting of the Quekett Microscopical Club was held on November 17, at 20, Hanover Square, W., the Rt. Hon. Sir Ford North, F.R.S., a Vice-President, in the Chair. There was, as usual, a crowded meeting.

Mr. H. Taverner, F.R.M.S., described a method of finding the depth of cells sunk in glass slips, by means of an engineer's internal depth gauge, reading with a vernier to within $\frac{1}{50}$ of a millimetre. He had found this a very ready and accurate method of judging the depth of cell required for objects to be mounted without pressure, whose thickness was already known.

It had been announced that the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., would read a paper "On some Experiments relating to the Insect's Compound Eye," but owing to his unavoidable absence through illness, a lecture by Mr. Frank P. Smith on "Spider Eyes," was substituted. After describing the differences between the two distinct types of simple eye which had been found in spiders, and which were distinguished as "nocturnal" and "diurnal" eyes, the lecturer proceeded to describe the arrangement of the eyes in the various families, which was found to be more or less connected with the life habits of the animal. He then described some of the abnormal types which had been observed and speculated as to their probable origin and meaning. A discussion followed in which several members took part.

Microscopists desirous of joining the Club at the commencement of 1906, should communicate with the Hon. Sec., Mr. A. Earland, 61, Denmark Street, Watford.

Unmounted Micro-Objects.

Mr. R. G. Mason, of 69, Clapham Park Road, S.W., sends me specimens of a series of interesting objects ready prepared for mounting, or requiring only soaking in spirits of turpentine beforehand. These are very suitable for beginners, and others would do well to obtain the list and peruse it, as by obtaining some of these sections they can, with a minimum of trouble and expense, add many interesting slides to their cabinets. Many of the botanical sections are double stained, nearly all are arranged in typical sets, and the cost only averages from one penny to three halfpence per slide. Full directions for mounting are sent with each series. Mr. Mason also sends me specimens of completely mounted objects, amongst which I may mention a fine section of limestone from Llanymynech showing unusually perfect fossil remains.

Notes and Queries.

S. C. Mitra, Bombay.—There is no book which deals specially with the structure of fibres under polarised light, the fact being that examination with polarised light is rather an aid than a principle. It seems sometimes to show up the central lumen and the striations, &c., of fibres very clearly. With regard to books, Hertzberg's "Paper Testing," which I recommended to a correspondent last month, has two large plates of excellent drawings of fibres, and Cross and Bevan's "Text-Book of Paper-Making" has an illustrated frontispiece of photo-micrographs; but the first-mentioned book would probably suit your purpose best. I am afraid I cannot promise a series of articles on micro-chemical reactions for fibres, as, with the exception of those I gave in my articles on "Fibrous Constituents of Paper," they are practically non-existent.

T. H. Russell, Edgbaston.—By projecting the image of the lines on a micrometer-scale on to a sheet of paper by means of a camera-lucida, marking the lines, and then, without disturbing any adjustments other than those necessary for re-focussing, replacing the micrometer-scale by the object-slide, and again marking the paper, you obtain identical values of magnification of both the markings on the micrometer-scale and of the object you want to be measured. The matter is not affected by any magnification or tube-length problems. You have marked on the sheet of paper magnified lines $\frac{1}{10}$, or $\frac{1}{100}$ of a millimetre apart, or whatever it may be, and you use these for the estimation of the size of the object. The camera-lucida is put ten inches from the table, because the normal visual distance is ten inches, but it is an arbitrary distance, selected for this reason, and has nothing to do with tube-length. If you are short-sighted you will *see* objects through the microscope smaller than the marks you have made upon the paper, because you do not form your virtual image 10 inches away, but less, and so get less magnification out of the microscope than an observer with a normal eye. The tube-length, of course, affects the total magnification, inasmuch as an objective used with a 6-inch tube only gives six-tenths of the *initial* magnification of the same objective used with a 10-inch tube. Then this initial magnification, whatever it may be, according to objective and tube-length, is multiplied again by the independent eyepiece magnification (hence the term "compound" as compared with a hand lens or "simple" microscope). The magnification of any one eyepiece is invariable and independent of tube-length. It is the objective which varies in this way, though most opticians' catalogues would lead you to think the contrary. Let me add that objectives are corrected for either short or long tube, and should be used with that length only for which they are corrected. The definition of the term "tube-length" is unfortunately vague; it may be "optical," or "mechanical," and even then different makers have different methods; but you will not be far off if you take the "mechanical" tube-length and decide to measure this from end to end of your tube when both objective and eyepiece are out, especially if you use uncapped eyepieces.

C. A., Surrey.—It is not easy to make a suggestion as to suitable subjects for investigation unless one knows something of one's correspondent's tastes and acquirements. There is one practical suggestion that I can make to you, however, out of many. Did you read Mr. Warburton's articles on "Mites" which appeared in these columns in May and June, 1904? If not, I would suggest your getting these numbers (if you have not already got them) and reading the article. It is a subject greatly neglected, and anyone who takes it up is sure to find many new species, for all of which he will get credit. They are very minute, and are found under loose bark, in lichen and moss, in fact, in any moss-grown wall or any coppice, and a bagful of material from an afternoon's walk will afford an evening's absorbing occupation. I know Mr. Warburton would be glad of help in collecting and examining, and I should be very pleased to put you in communication with him if you think well of my suggestion.

R.K.H., Woolwich.—I am very pleased to answer so pertinent and practical a query. Many workers with the microscope find themselves handicapped and their energies wasted and misdirected by just such want of preliminary scientific training as you deplore. Too many leave the matter helplessly, others obtain some standard and too often highly technical text-book on some special subject with the intention of reading it, and soon give it up in despair, discouraged at its complexities. It is a mistake to suppose that a man must undergo a course of training in a scientific laboratory if he is to do any good work. It is a great help to him if he can do so, and in certain subjects it is a necessary both for education and for self-discipline; but a man can do much by self-education if he has the root of the matter in him and will school himself to go steadily and consecutively through a prescribed course of study. It is essential that such study should include both reading and practical work, and the importance of the latter as a means of understanding the former can hardly be over-emphasised. To begin with Schafer's "Essentials of Histology" is quite useless for your purpose. It is meant for medical students only, and is in many respects a more advanced book than it professes to be. You could scarcely understand it, and certainly not appreciate it, without the training in human anatomy and in physiology which invariably accompanies the study of the subject, even if you had the necessary sections at hand to examine. Preliminary biological study divides itself into two heads—zoology and botany—and though you will probably not wish to go far in the former, you can go much further in the latter. When I say you will not go far in the former, I mean that you will probably confine yourself for the most part to the study of invertebrate animals. What I would suggest your doing is this. Get Parker's "Practical Zoology" (Macmillan), and read and work through the chapters on unicellular and multicellular animals, Amoeba, Paramoecium, Vorticella, Hydra, &c., obtaining the animals and dealing with them according to the explicit directions in the book. Then go on to the Earthworm and dissect it out carefully, also according to instructions, and if you care to go on further you can dissect the Crayfish, the Mussel, Amphioxus, and the Frog. I do not know whether your enthusiasm will induce you to continue further with the Dogfish and the Rabbit! The Frog, however, that martyr to science, you should certainly study carefully, and half the book deals with this animal. As companion text-book you cannot do better than read Shipley and McBride's "Zoology," published by the Cambridge University Press, which is specially written for the zoological course in the University of Cambridge. For the botanical side of Biology get Strasburger's "Practical Botany," and work carefully through it chapter by chapter. You will find most detailed practical instructions on every point, and I am not sure that you had not better begin with the botanical side first, but that is a matter for yourself. Many of the specimens you can obtain for yourself, other zoological ones you can get from Mr. Bolton, of Birmingham, and botanical subjects from Messrs. Backhouse, of York. I can scarcely insist too strongly on the educational value of such a course as I have mapped out, if conscientiously and systematically worked through. But it should not be attempted in any other way. If you want help or explanation on any point as you go on, I shall be very glad to assist you as far as I can.

[Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.]

The Face of the Sky for January.

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

THE SUN.—On the 1st the Sun rises at 8.8 and sets at 3.59; on the 31st he rises at 7.44 and sets at 4.45.

The earth is nearest the Sun on the 3rd, when the Sun attains his maximum apparent diameter of 32′ 35″.

Spots are numerous, whilst prominences as shown by recent spectroscopic observations are particularly active.

The position of the Sun's axis and equator is shown in the following table:—

Date.	Axis inclined from N. point	Centre of disc S. of Sun's Equator.
January 1	2° 22′ E.	3° 11′
,, 11	2° 29′ W.	4° 17′
,, 21	7° 15′ W.	5° 15′
,, 31	11° 36′ W.	6° 2′

THE MOON:—

Date.	Phases	H. M.
Jan. 2 ..	☽ First Quarter	2 52 p.m.
,, 10 ..	○ Full Moon	4 37 p.m.
,, 17 ..	☾ Last Quarter	8 49 p.m.
,, 24 ..	● New Moon	5 9 p.m.
,, 4 ..	Apogee	4 0 p.m.
,, 20 ..	Perigee	6 12 a.m.

OCCULTATIONS:—

Date.	Star's Name.	Mag.	Disappearance. Mean Time.	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.	Moon's Age.
			p.m.		p.m.		d. h.
Jan. 4	ξ² Ceti	4.3	4.12	10[illegible]	5.10	2[illegible]	9 12
,, 7	B.A.C. 1520	5.8	6.53	10[illegible]	8.2	23[illegible]	12 15
,, 14	σ Leonis	4.1	11.1	134	11.58	20[illegible]	19 [illegible]

THE PLANETS.—Mercury (Jan. 1, R.A. 17^h 7^m; Dec. S. 20° 35′. Jan. 31, R.A. 19^h 57^m; Dec. S. 22° 17′) is a morning star in Sagittarius, and is at greatest westerly elongation on the 4th, when he rises about 6·15 a.m. This elongation is not a very favourable one.

Venus (Jan. 1, R.A. 17^h 50^m; Dec. S. 23° 26′. Jan. 31, R.A. 20^h 40^m; Dec. S. 19° 28′) appears in close proximity to the Sun, and is practically unobservable.

Mars (Jan. 1, R.A. 22^h 24^m; Dec. S. 11° 2′. Jan. 31, R.A. 23^h 48^m; Dec. S. 1° 50′) is an evening star in Aquarius, and appears in the sky a little to the east of Saturn. Near the beginning of the month the planet is on the meridian about sunset, but in consequence of now being at a great distance from the earth he appears but a feeble object.

Jupiter (Jan. 1, R.A. 3^h 40^m; Dec. N. 18° 41′; Jan. 31, R.A. 3^h 35^m; Dec. N. 18° 41′) is due south at 8 p.m. near the middle of the month. The planet is describing a retrograde path near the Pleiades, is at the stationary point on the 21st, after which his motion is direct or easterly. The equatorial diameter of the planet on the 14th is 45″·0, whilst the polar diameter is 2″·9 smaller. The planet is very favourably situated for observation, and even in very small telescopes his belt-like markings and attendant moons form an interesting object.

The following table gives the satellite phenomena visible in this country before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Jan.				Jan.				Jan.			
1	I.	Tr. I.	9 31	10	I.	Sh. I.	7 0	21	III.	Sh. I.	7 19
	II.	Tr. I.	9 36		I.	Tr. E.	8 10		III.	Sh. E.	9 19
	I.	Sh. I.	10 3[illegible]		III.	Oc. D.	8 57	24	I.	Tr. I.	9 37
	II.	Sh. I.	11 3[illegible]		I.	Sh. E.	9 13		I.	Sh. I.	10 51
	I.	Tr. E.	11 5[illegible]		III.	Oc. R.	10 46		II.	Oc. D.	11 31
2	I.	Oc. D.	[illegible]		II.	Ec. R.	11 18		I.	Tr. E.	11 50
	I.	Ec. R.	[illegible]	11	I.	Ec. R.	6 27	25	I.	Oc. D.	6 54
[illegible]	I.	Sh. I.	5 [illegible]	12	II.	Sh. E.	6 11		I.	Ec. R.	10 19
	III.	Oc. D.	5 [illegible]	14	III.	Sh. E.	5 17	26	I.	Tr. E.	6 18
	I.	Tr. I.	6 2[illegible]	16	I.	Oc. D.	10 35		II.	Tr. I.	6 20
	III.	Oc. R.	7 1[illegible]	17	I.	Tr. I.	7 4[illegible]		I.	Sh. E.	7 33
	I.	Sh. E.	7 18		I.	Sh. I.	8 55		II.	Sh. I.	8 51
	II.	Ec. R.	8 43		II.	Oc. D.	9 4		II.	Tr. E.	8 56
	III.	Ec. D.	9 16		I.	Tr. E.	9 59		II.	Sh. E.	11 28
	III.	Ec. R.	10 59		I.	Sh. E.	11 8	28	II.	Ec. R.	5 48
[illegible]	I.	Tr. I.	11 30	18	I.	Ec. R.	8 23		III.	Tr. I.	6 17
[illegible]	I.	Oc. D.	8 45	19	I.	Sh. E.	5 37		III.	Tr. E.	8 14
	I.	Ec. R.	11 59		II.	Sh. I.	6 12		III.	Sh. I.	11 20
[illegible]	I.	Tr. I.	5 57		II.	Tr. E.	6 25	31	I.	Tr. I.	11 29
	II.	Oc. D.	6 40		II.	Sh. E.	8 50				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc and "Sh. E." its egress.

Saturn (Jan. 1, R. A. 22^h 8^m; Dec. S. 13° 9′. Jan. 31, R. A. 22^h 20^m; Dec. S. 12° 0′) is now getting to the west and will soon be out of range; near the middle the month the planet sets about 7.30 p.m. The northern surface of the ring is presented to us and we are looking upon it at angle of 9°.

Uranus (Jan. 1, R. A. 18^h 21^m; Dec. S. 23° 37^m) appears in close proximity to the Sun and is therefore unobservable.

Neptune (Jan. 17, R. A. 6^h 37^m; Dec. N. 22° 13′) is due south about 11 p.m. near the middle of the month. The planet is situated in Gemini, some 6° east of the star μ Geminorum, but in small telscopes it is difficult to identify among the numerous stars in the same field of view, but he can be detected by his slight motion if observations are made on several successive nights.

METEOR SHOWERS:—

Date	Radiant. R.A.	Radiant. Dec.	Name.
	h m.		
Jan. 2-3	XV. 20	+53°	Quadantrids.
,, 17	XIX. 40	+53	θ Cyganids.

Minima of Algol may be observed on the 15th at 11.4 p.m., the 18th at 7.53 p.m., and the 21st at 4.42 p.m.

ο Ceti (Mira) should be watched, as it will probably reach a maximum during the month.

TELESCOPIC OBJECTS:—

Nebulæ.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star θ, is the finest of all nebulæ; with a 3 or 4 inch telescope, it is best observed when low powers are employed.

Crab Nebula (M 1), in Taurus, situated about 1½° north-west of ζ Tauri in R.A. 5^h 29^m, Dec. 21° 58′ N.

Clusters.—M 37, situated in Auriga, is one of the finest clusters, and very compact, its position is R.A. 5^h. 46^m., Dec. 32° 32′ N.

DOUBLE STARS.—β Orionis (Rigel), mags. 1 and 9, separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

δ Orionis, mags. 2 and 7, separation, 53″; easy double.

ζ Orionis, triple, mags. 3, 6, and 10, separation 25″ and 56″; rather difficult in a 3-inch telescope.

λ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

σ Orionis, triple, mags. 4, 8, and 7, separation 12″·5 and 42″.

SUPPLEMENT.

London's Transformation.

A Suggestive Sketch of Days to Come.

(*Continued from page 314.*)

By TEMS DYVIRTA.

[Cornelius Tush was a great American financier, whose modes of business were perhaps not always quite above suspicion. He had hit upon the great idea of diverting the course of the Thames so as to cause the river to flow away to the country, and leave its dry bed in London available for building sites. He had made business arrangements with a number of people, had formed a large Company to make the deviation, and finally the work was completed. Tush, however, was sorely disappointed with the treatment he had received in England, where many people looked askance at his methods, and had returned to America.]

CHAPTER VIII.

LIBERTIA STREET.

A period of peaceful repose having healed the soreness of his heart, Tush had returned to England to view the outcome of his ambitious scheme.

For the third time he stood on Westminster Bridge and leant upon the parapet to gaze on the scene below. And well might he ponder, for what a different sight now presented itself to his eyes to that on which he had looked so long ago, when nothing but a sea of turbid waters flowed beneath, and later, when the busy hum of machinery resounded over the irregular masses of heaped-up earth and woodwork. What he now looked down upon was an extensive view of the finest street in all the world. A thoroughfare worthy of the great city of London. "Libertia Street" ("Avenue" was originally suggested, but the old English "street" finally adopted) is over 200 feet wide. On either hand rise magnificent new buildings of imposing architecture. The sound of the hammer and of the trowel still resounds in the air, telling of the new structures arising among the scaffoldings between. Here, on the right, is the huge "Hotel Thames," with its tiers of balconies rising high above the bridge. There to the left, with its gilded statuettes, is the Royal Thames Theatre. Next that of the prettily turreted building of the new Radical Club, while opposite is the great block containing the "World's Emporium," and further on is the great National Opera House. Away in the distance are the towers of the new Palace of Justice. Besides the many handsome detached edifices are the rows of shops and business houses. Their ground floors abut on the street, and contain for the most part the parcels offices and packing stores, readily available to the carts in the street, while, in many cases, vehicles can drive in through porticos to inner court yards. On the roofs of these lower stories runs a wide pavement for pedestrians. At intervals are inclines or steps leading to the roadway below, and foot-bridges span the side streets. Glass verandahs jut out over the shop fronts, giving shelter from the rain, while not darkening the display of tempting goods in their windows. Above them the great buildings rise to six or eight stories high, even looking down from their parapets on their poor old kindred of the high-level town around them.

Every building is of artistic design, and all now look so bright and clean in their newness, that a very pleasant effect is presented to the eye. Down the centre of this great thoroughfare runs an avenue of fresh green trees, bordering a gravel walk, whereon are seats and chairs, shelters from the sun and rain, drinking fountains, newspaper Kiosks, coffee stalls and retiring rooms; all beautifully and tastily arranged, at hand, yet not interfering with the traffic. Even monuments are in course of erection in suitable spots; these are not ugly bronze figures of men in everyday attire standing on solid blocks of stone, with blackened faces, unrecognisable as representatives of their originals. Such statues are no more picturesque than the passers-by themselves; but here are artistically-grouped statuettes on ornamental pedestals.

On either side of the central avenue are cab-stands and space for waiting vehicles, and tram lines run along outside. Then comes the enclosed road reserved for the out-of-date horse-drawn traffic, which, of course, is prohibited from sullying and wearing out the clean asphalt, on which the horses would, moreover, be slipping down and running away. Outside this are the broad, open, asphalted roads, now teaming with traffic overflowing from the much congested thoroughfares of the old city, and forming a splendid unimpeded route from East to West of London. For this great highway extends along the course of the old river as far as the new Docks at London Bridge. There a fine wide wharf runs across the river, forming a fitting point of departure for the smaller passenger boats leaving the port of London. What a pleasant change from the dirty old crowded wharves of olden days! Any day one may see ten or a dozen steamers lying with their sterns towards the wide quays, embarking heir passengers as trains do at a large railway terminus.

Along the old embankment (the stone facings of which have now been moved to line the sides of the Canal) are the shop fronts of the new houses whose lower floors abut the fine, though comparatively narrow streets which run along parallel to the great Libertia Street.

To the south of the main thoroughfare runs a second narrow street, and in this are some of the huge buildings affording comfortable accommodation for thousands of the working classes. All are built on the latest approved methods and with all the modern appliances for living in health and comfort. Each family has its own suite of rooms, with balconies and window gardens, and everything that a poor Londoner can expect. Many of their windows overlook the Canal, which important waterway connects the docks with the various city warehouses and enables water traffic to be conducted from the lower to the upper Thames.

It was a bright sunny day, for days are generally brighter now; no longer do such dense fogs hang about the valley of the old river. Fog is but the visible effect of aqueous vapour suspended in the air; without the expanse of cold humid water and damp earth this could not exist. The minute particles of smoke, which, dampened by the vapour, form the pall which used to hang over the city, are now dry and fall to the ground as dust, leaving the sunshine to warm the air and beautify the surroundings.

Yet was Cornelius dull. "Uneasy lies the mind that grabs the gold!" Troubles seem unending. A journey to the States and a sojourn there of eighteen months should have appeased the public mind. Their new plaything should have caused Londoners to forget their petty squabbles with the donor. But no! he had come back to find himself an outcast, shunned by all. He had arranged to see his solicitor that day and to discuss with him the unsatisfactory aspect of affairs. But first he would have a look around the new city of his creation. Descending by some steps, he pursued his way along the great broad walk beneath the bridge. What a grand sight now met his gaze! For a magnificent open space lay to his right, laid out with flower beds and grass plots, and beyond a truly noble flight of steps, broken with balustrades and statues, forming the grand approach to the historic terrace from which rose that noble pile, looking so much grander when seen from below, of the Palace of Westminster.

For some time he stood wrapped in admiration. He felt that the British House of Representatives now really equalled that of the States; for how would the Capitol at Washington appear, from an architectural point of view, were it situated in a depression, and looked down upon instead of being looked up to?

Further on, great houses with their shop fronts again walled in the streets. To the left was a bridge spanning the Canal, now packed with barges being towed up and down to the various wharves lining its sides. All was changed and altered! Like the inhabitants themselves! The very buildings in their grandeur seemed to cut the millionaire dead! Calling up a motor car he jumped in and was whisked off to interview his lawyer and hear how things were developing. Rapidly he was sped along the smooth asphalt down the great thoroughfare. Onward he went under Westminster Bridge, past the great Northumberland Avenue approach whence a glimpse of Trafalgar Square could be obtained, till, passing up on to the Embankment near Waterloo Bridge, he was deposited before the great buildings of the New Temple facing the Inner Temple Gardens. Here were situated numbers of new chambers for barristers and solicitors, who, in their increased numbers had flooded out the older rookeries of legal experts.

Entering the offices, he there found assembled some half-dozen men, his associates in business and others. The grey-haired solicitor eyed him gravely as he entered, and spoke earnestly in a hushed undertone. Serious, indeed, was the import of his words. The interview did not last long. Tush, for a wonder, was very taciturn, and said but little in reply to the anxious exhortations of the lawyer. Presently he turned and caught sight of Bateson, who was standing whispering mysteriously to one of the others with his eyes fixed on Cornelius. "*You* have brought all this on me," roared Tush, livid with rage. "You scoundrel!" Then, turning to the others, he recognised some of the prominent shareholders in the great company, some who had been addicted to asking awkward questions. "That I," he muttered through his teeth, "I, who could buy up this whole blessed city, that I should receive such insult! Such ignominy! You dare to threaten me, do you? Call me 'swindler' and have me up in your dirty Law Courts for fraud! No, no, my friends. You'll find *that* won't pay. Why, I could put you down a million apiece to keep your tongues from wagging, aye, and not feel it. Only I *won't*. I'll have nothing more to do with you darned Britishers. I've got all the dollars I want out of you, and now I can face my own countrymen, thank God! Only I should like to spoil all that fine street I've made for you first. Thankless curs!" And turning on his heel he left the room.

CHAPTER IX.

THE NEW THAMES.

Happy is the man who amidst life's storms has ever at hand a harbour of safety wherein he can obtain rest and peace; a home of refuge for his troubled mind, a comforter and friend, in whom he can confide, and lucky was Cornelius in having such a possession still to fall back upon.

Returning to his rooms in the palatial Thames Hotel he found his faithful Alma and his petted and affectionate daughter. What soothing influence they brought upon his agitated brain! "Alma," he said calmly, "we must leave this cursed country. Never again shall I put foot in it. We will return to our own old States, and there we may find peace and happiness, but not here; we must be off by the first boat." His tactful wife soon grasped the situation. She saw how greatly her husband was worried over his business, and she, too, knew how dangerous that was for him whom the doctors had declared possessed of a weak heart. She soothed him gently, but still she divined the serious causes that influenced his intentions. "Cornelius," she replied, "you are worried and upset. We cannot start to-day. Let us, then, go for one more delightful quiet sail on the lovely river. It will do you good, you know it always does."

So leaving their rooms the trio went forth, bent on enjoying the last few hours they might have in England. How little did they think that for one of them it was the last few hours in any land!

Within a short space of time they were rattling along in the train through the southern districts of London, when, on passing clear of a large factory, a brilliant scene was presented to their eyes. A peaceful, pleasurable sight, yet one to sicken and embitter Cornelius' feelings! Another of his creations to be presented to his enemies, for the train approached a long, a very long bridge, and this bridge spanned a broad stretch of water, the New Thames! Looking down from this eminence a good view of the grand river was obtainable. Dotted about on this were numerous sailing boats and small yachts, beating their way hither and thither, their white sails looking so clean and bright against the blue water and the green trees beyond, for there on either bank were the newly laid-out gardens of many little villas cropping up like mushrooms all around. This splendid artificial lake, here of great width, but further on narrowing into the gorge of the great cutting through the Surrey Hills, formed, indeed, the much-needed playground for boat-loving Londoners. How much appreciated it was by the old hands who had steered their craft on the narrow and enclosed reaches of the old Thames! And what lovely little surburban retreats there were springing up upon its rising banks! In a few years more, when those young saplings had attained mature dimensions, would not those wooded slopes compare even with the picturesque confines of the Bosphorus?

Soon the party had alighted at the little station now crowded with people clad in white flannels and straw hats, for it transpired that a regatta was being held. Thence they walked down to the river-side and on to the landing stage of "Tyler's," and soon were seated in the smart little centre-board yacht, the *Water Witch*. This vessel had been bought by Cornelius but a few days previously as a means of escape from that society which he now so disliked. But a few minutes more and the little ship was sailing off gaily before the strong gusts of wind which rippled over the deep blue water, breaking up the monotony of colour from the ice-like calm under the windward banks.

No feeling is pleasanter, no motion more calming to the mind, than that of gliding in a sailing boat through the water in a fresh breeze, with the gurgling sound of the tiny waves rippling against the sides of the vessel.

Cornelius, ever determined to have the supreme command in all things, took the helm and piloted the yacht on its voyage. First they sailed over to where the regatta was being held. The course, clearly marked out with buoys, almost as distinctly as a race course ashore, had to be crossed at one of the points arranged for the purpose at stated intervals. "Heaving to" for a time, the party were able to watch one of the races, which were well seen, too, for the whole length of the course by the hundreds of spectators comfortably seated about on the slopes of the rising river bank. How preferable to the crowded towing paths of the old Thames on such occasions!

This wide portion of the river had been so constructed in conformity with one of the stipulations of the Government, influenced by a deputation from the combined sailing and rowing clubs. Lower down the rising hills involved large and expensive cuttings, and there, consequently, the river was narrower.

Having taken a turn among the mass of boats full of onlookers, and past some of the launches lying away while their occupants consumed their champagne and ices, the little family party decided on taking a trip further down the river; further from the "madding crowd." The *Water Witch* soon sailed in under the lee of the great cutting and was almost becalmed, drifting slowly along with the current. Steering now being unnecessary, if not impossible, Cornelius left the tiller, and making fast the main sheet to prevent the boom swinging over, reclined at his ease close to where his wife and daughter were sitting. This was truly bliss! What need to quarrel with one's fellow creatures when one's time could be spent drifting thus leisurely in the quiet summer evening so far from all worries and troubles, and even able to avoid the inquisitive and sometimes scornful gaze of passers-by.

Everything seemed peaceful and still. Other boats were being sailed and rowed about, but none were near enough to disturb the repose of the occupants of the yacht.

All of a sudden the wind freshened. They had drifted on beyond the bluff to where a valley ran down towards the river. Before the party realised their position a strong squall caught the sail now tightly fixed by the main sheet. The boat gently heeled over more and more. Cornelius sprang to the helm, but in his hurry tripped and fell sprawling to the lee side. This extra weight suddenly thrown on the beam was the finishing touch, the gunwale sank under the water, the vessel rapidly filled, and turned on its side, the mast and sail sinking under. All the occupants were thrown into the river. Libertia, an expert swimmer, had seized her father as she saw him rolling into the water, and now held him with one hand, as she clung to the half-submerged boat with the other. In vain they struggled to right it. Cornelius was no swimmer and could assist but little, and for some moments was so involved in gasping for breath and getting a firmer hold of the boat that he did not notice the absence of his wife. "Alma," he gasped, "Alma, are you safe?" But no response came. No response beyond the agonizing cry of Libertia, who plunged under water in the vain hope of seeing her mother. But never again was that fair form seen alive. Held down beneath the sail her last breath must have been soon drawn, and ere the witnesses of the disaster, who hurried their boats to the spot, had rescued the immersed couple, her body must have sunk beneath the depths of water which, but for her husband, would, perhaps, never have covered that spot. Poor Alma! That sweet accomplished, faithful wife and mother, whose life had always been such as any woman might envy; upright, self-sacrificing, and true, was gone for ever.

Many hours had passed before the body with its beautiful white face, calm and serene, was dragged from the river and laid on the bank while endeavours were vainly made to restore animation.

A few days more and all that was left of his beloved wife had been laid in their last resting place, not far from the banks of that treacherous stream, and Cornelius took his heart-broken daughter back to their own mother-country, bidding farewell, as he said, for ever, to this land of spite and thanklessness.

CHAPTER X.

Setting the Thames on Fire.

It was in the early hours of the morning on the day following Tush's departure for America, when all the town was hushed in silence, or as near approaching that state as it ever is, one of the watchmen at the "World's Emporium" was going his rounds when he detected a smell of burning, and passing through the building to the department whence he thought it emanated, found the place full of smoke. He then suddenly noticed one of his mates lying on the floor apparently insensible. As a matter of fact, he felt somewhat suspicious at the time as he did not consider the smoke so thick at that spot as to cause asphyxiation, and he very easily aroused the watchman to consciousness. It was then discovered that a very extensive fire was raging, also that the "automatic sprinklers," which should have at once sent a deluge of water on the spot, had ceased to act, as though the water had been turned off. The alarm was quickly given, and in a very short space of time the fire brigade was busily at work subduing the flames. One after another motor fire engines came dashing along the empty streets, and drew up before the burning building. Hoses were soon got out and attached to the hydrants, and before long tons of water were being poured on the flames.

But whilst this was going on, a policeman on duty by the Canal near Southwark, noticed smoke issuing from a large new warehouse, and soon a second great conflagration was in progress. Urgent calls were issued to outlying stations, and the fire brigade had its hands full. A third fire was then reported down near the new Docks, and hardly had this been taken in hand than it was found that the upper floors of the Thames Hotel were ablaze. All this was a tremendous strain on the brigade, and it would have become a very serious matter, indeed, had it not been for two facts. Firstly all the houses had been constructed in conformity with stringent rules issued by the London County Council regarding various details for the prevention of fire. Such would have been impossible to apply to existing buildings, but these had been introduced after receiving the most careful attention when first it had become certain that a large number of new buildings were to be erected. It was then decided that this would be a great opportunity for introducing new regulations with regard to the construction of all edifices. All were to be fitted with automatic alarms (though in each of the present cases these had, for some unaccountable reason, failed to act). Among other details all were furnished with hydrants and stand pipes to suppy a copious amount of water under considerable pressure. Various means of escape, too, had to be provided, and fire-proof materials entered into the construction and fittings.

The second reason for the comparative ease of being able to subdue the flames was the ample water supply flowing from these hydrants. Great mains had been laid in the old river bed whence an inexhaustible volume of water came direct from the Thames. This arrangement proved to be of the greatest use for fire extinction, as a mass of water, almost to be comparable to a river itself, could be poured on the flames.

The fire raging at the hotel presented a most exciting spectacle to the great crowd which soon assembled. The guests dashing to the windows of their rooms were seen to cast out some simple folding ladders (in conformity with the printed directions in all the rooms), and by this means were enabled to reach the balconies below, whence, by the iron staircase, they could descend to the main balcony above the street. Hundreds of them in all variety of attire were streaming down the front of the building, looking for all the world like so many white ants whose nest has been disturbed. Owing to these excellent arrangements there was no loss of life in the enormous building.

Firemen, and even policemen and soldiers were, on the other hand, scaling the building with their ladders to direct thin jets of water in at the windows from the hose attached to the iron pipes, which conveyed a copious supply of water to the tops of the houses. The great, wide street, and the bridges that spanned it, formed advantageous coigns of vantage for the many thousands who had come to watch the sensational operations. Very soon, however, thanks to the timely measures which had been adopted, each of the fires was extinguished.

Then, as all the spectators wended their several ways homeward, tongues got wagging, and everyone was enquiring how so many fires originated at the same time all in this one new district. Later on other facts came to light. Eventually it transpired that some large insurance operations had been effected in the name of Tush. Then did some recall certain words used by that gentleman in the solicitor's office just prior to his leaving the country.

Many of those returning to their homes or going to their day's business made their way eastwards through the great markets under London Bridge. Now that old Covent Garden had been transformed and built over this was the centre whence Londoners obtained so much of their food supplies. Magnificent conservatory-like buildings rose on all sides, and the well-paved floor was kept scrupulously clean by lavish drenches of water.

Among the stream of those passing through, one man was noticeable, for in him we may recognise the agent, Bateson. Continuing his way into the purlieus of Bermondsey he might have been seen to visit certain low haunts, become engaged conversing and discussing matters with several well-known disreputable characters, and effecting certain monetary transactions with them. This done, he threaded his way back to the city. Later on Mr. Bateson might have been seen entering the colossal portals of the "Tush Buildings," situated just beyond Blackfriars Bridge. Ascending rapidly in the hydraulic lift, he was landed on the 11th floor, where were the offices of the Griffin Insurance Society. His business was, he explained, to claim on behalf of Mr. Tush, immediate payment with respect to insurance policies issued in his name on certain buildings situated in Libertia Street and that neighbourhood, which had been damaged by fire on the previous night. He explained that the reason of his somewhat sudden demand was because of Mr. Tush's departure for America. "But," retorted the manager, "this is just a matter on which I was requiring some information. I happened to meet Mr. Tush some days ago, and knowing that he had lately insured a number of buildings in very large amounts, I alluded to the matter, when, to my surprise, he denied having effected any insurances whatever." "Ah, you see," replied the agent, "Mr. Tush is a peculiar man. His hands are so full of business that he frequently forgets what little affairs he has transacted. Now I manage all these things for him and keep count of them, and I hold his power of attorney for transacting such business." Nevertheless, the manager was not at all satisfied, and as rumours had reached him with reference to suspicions as to the origin of the fire, he politely declined to redeem the policies pending further enquiries. Bateson was evidently somewhat disconcerted about this and left the office abruptly.

It was a hot, stifling day. In some of the older quarters of the town life seemed almost unbearable. Warm blasts of wind sent clouds of dust to thicken the air and fill the eyes and lungs of passers-by. The glaring rays of sun, almost tropical in its intensity, beat down upon the dry-mouthed, sweating wayfarers. Dust penetrated everywhere, and whence this dust? The disintegration of the road material by the continuous hammering of iron boots and crunching of iron-bound wheels, the refuse strewn over the streets by the horses, and the gravel scattered upon them to prevent the slipping during damp and frosty weather. But the new districts in the river-bed were better off. Foot passengers strolled beneath the green trees or shady verandahs, while the clean asphalt, unworn by the soft rubber tyres of the motors, emitted no dust, and the plentiful water supply enabled the roadways to be profusely sprinkled from the many stand-pipes.

Bateson wandered about uneasily trying to rest under the soothing influence of the shady trees in the centre of the street. He was cogitating on his future actions. Finally he decided, being somewhat apprehensive of what the future might bring, on getting together, while there was yet time, as much personal property as he could collect. With this object he walked off to the Bank of England. This national storehouse of wealth, emblematic of the mighty Empire, had long since outgrown the old buildings in Threadneedle Street, and was now contained in that splendid block extending from Cannon Street on the north and continuing south to its noble facade in Libertia Street, thus connecting the old city with the new. Business in London was now double what it was twenty years ago, and the Bank of England is but an index of its magnitude. As with many other institutions, it is difficult to comprehend how they could have been sufficiently enlarged to cope with the growth of trade and increase of wealth, had it not been for the utilisation of the Thames.

Passing through the grand entrance hall, Bateson hurried nervously along and visited one department after another (and the interior of this office may be compared to a small city in itself), endeavouring to effect the somewhat complicated business he had in hand. In due course it was all satisfactorily arranged, and he quitted the building to visit another of those great piles of offices towering into the sky, numbers of which had been erected in this neighbourhood, adding immensely to the much-needed business accommodation of the city.

Here he asked for an interview with the manager of another large fire insurance company. This time Mr. Bateson was still less fortunate than before, for certain inquiries had in the meantime been made and certain transactions come to light. The result was, that after being detained for a very considerable time in the waiting-room, the manager entered accompanied by another man, and after a few words of explanation, introduced the latter as an official from Scotland Yard, who would conduct Mr. Bateson to a certain place where further investigation was now being made as to the origin of last night's conflagrations. And it may here be added the result of these investigations were so unfavourable to that gentleman that for a long time afterwards he was not seen in public.

(*To be concluded.*)

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CONTENTS—See page VII.

The Coloration of Mammals and Birds.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S., M.B.O.U., etc.

(*Continued from page* 317.)

Let us now consider for a moment the question of those mammals whose pelage changes at certain seasons of the year.

Roughly speaking, in the tropics, the wet and dry seasons correspond to our summer and winter, so that, if an animal is to be at all affected by the climate, the affection will show itself, roughly speaking, in spring and autumn, at the same time, approximately, as when the cold or heat are affecting the animals of more northern climes.

Mr. Lydekker, in an article in the *Field*,* points out that *Sciurus caniceps* was the only tropical mammal that, to his knowledge, had a seasonal change. This particular squirrel, in company with another, *S. atrodorsalis*, assumes in mid-winter a very bright or intense coloration on the back, which, as I have pointed out† some years ago, is caused by the advent of sexual activity, and not by any climatic or seasonal change. The climate at that time of year (December to February) is very constant, and this is, therefore, a clear instance of a change being brought about solely by sexual activity.

On the other hand, we have certain species, such as *Sciurus maclellandi*, *Funambulus berdmorei*, etc., in which their season of most intense colouring coincides with the summer or wet period, but in this case the change is merely one of relative brightness and not so marked as in the other cases.

Among birds, the changes seem to be almost always "breeding changes" for they take place at the breeding season and are probably due almost entirely to sexual causes and impulses, and we would suggest that any changes in the tropics which may take place, as being purely due to *seasonal* causes, are to be found among the representatives of northern races where the necessity of a change arose and has not yet been eradicated. A good example is to be found in *Mustela flavigula*. This animal, which is of a light brown and yellowish colour in Siberia, has in Nepal a marked seasonal change, becoming much darker in summer. In the Malay Peninsula, although both pelages are darker than those assumed in the North, the seasonal change still persists, while in Java and Sumatra, the dark brown form is permanent throughout the year. In the Peninsula of India is also found another species (*M. gwatkinsi*), which is uniformly dark, and has, as far as we know, no seasonal change.

* *Field*, 1903, p. 675. † *P.Z.S.*, 1901, p. 52.

To sum up concisely :—

Conditions of climate being more equable, "changes of pelage" are not so frequent in the tropics as in more northern climes; when they do occur, they are probably due—

(1.) Either to the sexual impulses alone, *e.g.*, *S. caniceps* and *S. atrodorsalis*.

(2.) Or to a long ingrained habit,* owing to the animal having originally come from some climate where seasonal change was necessary, *e.g.*, *Mustela flavigula*, *Cervus*† and possibly *Sciurus*.

TEMPERATE REGIONS.

After all that has been said on the other regions, there is not much to note here, except to point out that the arguments for the other regions still hold good.

In the first place it is fairly self-evident that in most of the mammals and birds of this region the prevailing coloration is brown; white mammals are as scarce as they are in the tropics, and bright coloured forms belong, without exception, to tropical or cosmopolitan families. The squirrel and the fox are good instances of mammals that have partially retained their bright colour, the former during summer only, the latter throughout the year; the deer also are red in summer.

The birds also call for little comment on these lines. The bright species, as the kingfisher and roller, being typical of the tropics, and the Sylviidæ, or warblers, typically birds of the temperate region, are brown.

The chief interest of the temperate region, however, lies in those families that, stretching from the north and even penetrating the Arctic circle, may also be found on the northern edge of the tropics, becoming brighter and brighter gradually and throughout the whole distance as they approach the southern limit of their range.

More heat, better and more abundant food, more time between the periodic breeding season and the cold of winter, or the gentle advent of spring, all these are causes which, as we have shown, may and do affect the "vigour" of the individual, and it is by means of that "vigour" and not by their direct action that we suggest the brighter colours are produced.

* It is not advisable to press matters too minutely in a general paper, but it is perhaps worthy of note that in *Cervus eldi*, an inhabitant of Burma, Malay Peninsula and Cochin China, the brightest pelage is that assumed and worn in winter, and is therefore hardly analogous to the changes in *C.* [illegible], whose brightest phase is in summer. I would therefore suggest that the change in *C. eldi* is purely a breeding change and that it has progressed a stage further than *C. axis* and *C. unicolor*, that have a similar pelage throughout the year, in having first eliminated the seasonal change and then adopted the breeding change; this would merely depend on the balance between the sexual and climatic impulses.

† For a further instance of the seasonal change persisting under altered conditions, see Captain Barrett-Hamilton, *P.Z.S.*, 18[illegible], p. 598.

(*To be continued.*)

The Evolution of the Flower.

By S. Leonard Bastin.

(Continued from page 324.)

PART II.

The conspicuous and often attractively coloured sepals and petals of the flower, whilst serving their special purpose, are, after all, of but small importance when compared with the organs which fill up the centre of the typical blossom. These, as is well known, are divided into two distinct kinds—the stamens and the carpels—the latter collectively forming the pistil. The former organs produce the pollen grains which, coming into contact with the latter, fertilise the ovules and thus bring about the production of living seed. As a rule the stamens are in the form of small processes having slender stalks surmounted by heads or anthers; it is on the anthers that pollen is produced. The pistil, as has been stated, is composed of a number of carpels, and these are sometimes very distinct, or, on the other hand, they may be all joined together. Each carpel terminates in a longish pillar called a style, at the summit of which is the stigma, a moist, fleshy surface to which the grains of pollen readily adhere. At the base of the carpel is to be found the ovule, that highly specialised organ which is the forerunner of the seed.

At first sight it is not an easy matter to determine what may be the origin of the highly complicated male and female organs of the plant. Both the sepals and the petals of a flower exhibit more or less resemblance to the foliage of the plant, but there is certainly not much obvious connection between stamens and pistil and the leaf. Nevertheless, after the consideration of the instances which it has been the purpose of the present paper to bring together, it will be easy to credit the statement that the leaf was the ancestor of even the reproductive organs themselves.

In the Begonia, the near relation between stamens and petals is clearly observable.

In the case of the so-called "double" flowers it will be readily seen that a very large number of extra petals have entered into the composition of the blossom. These additional petals must have had their origin in something, and, as a matter of fact, they are degenerate stamens. The manner in which this transformation of stamens into petals is carried on is readily seen in the case of the Begonia. The florist has hitherto been completely vanquished in his attempts to produce a variety of Begonia which shall throw nothing but double flowers on each spray—a single flower always putting in an appearance. Occasionally a blossom is to be found in a curious midway state between the single and double condition, and when this is the case an interesting side light as to the connection between stamens and petals is to be seen. It is possible to trace the gradual degeneration of the stamens into the petals; some of these eccentric organs are just simply flattened stamens, resembling miniature petals except for the fact that they are covered with a deposit of pollen. Others have got away from the pollen altogether, have developed the coloured tissue, and are perfect petals in their way except that they are very small.

Probably one of the most marvellous object lessons in the whole of the plant world bearing on the origin of the stamens is to be seen in the case of the flowers of the Water Lily (*Nymphæa alba*). By a careful dissection of the flower of this plant a most instructive series of organs may be compiled, in which all the stages between the stamens and petals may be discerned. Starting away from the outside of the flower with the green sepal, it is interesting to note that this is partially coloured white, offering yet another proof of the origin of the petal. Passing over several rows of perfectly formed petals, it is noticeable that these are steadily decreasing in size the nearer one gets to the centre. Gradually these petals become modified in form until they are quite narrow, and at last one is seen to be curiously thickened at the point. This point is yellow in colour, and a microscopic examination of the substance reveals the fact that it is pollen. The termination of this organ, which one can call neither stamen nor petal, as one advances inwards, continues to be more and more modified until it resolves itself into two thickened parts; eventually these meet together and form the two lobes of the anther. Moreover, at this stage the petal-like process disappears altogether, narrowing down until it forms the filament of the stamen. In the inside rows of the stamens it is not possible to discern any resemblance between the petal and the male reproductive organs.

The near relations between the stamens and petals of the Water Lily flower are very evident.

A similar process to that which is so striking in the case of the Water Lily flower is to be seen in the blossom of the Pæony, and, as well, other instances might be noticed. But it will scarcely be necessary to bring forward further proof in support of the assertion that there is a very intimate connection between the stamens and the petals of the flower. As has been clearly shown on a previous occasion, the petals of the bloom have been obviously developed from the stamens, and these latter bring us back to the all-important leaf.

Carpel of a single Cherry bloom (left) compared with leaf-like carpel of double Cherry flower.

To trace in a clear fashion the leaf origin of the pistil is not quite such a simple matter as it was in the case of the other three organs of the bloom which have already been dealt with. As is well known, the pistil is composed of one or a number of carpels, and these last bear at the base the wonderful ovules. A small amount

A Double Cherry bloom with the centre petals removed, exposing the small leaf in the centre.

of investigation, however, will prove that these complicated and highly specialised organs have a leaf ancestry just as much as any other part of the flower. In a general way, although the stamens of the flower are, in the case of double blossoms, sacrificed to make up the additional petals, the pistil is in a more or less perfect condition. But there is just one double flower which lets a good deal of light on to the question of the origin of the pistil. This is the double Cherry, a flower which it will well repay anyone who is interested in the matter to study a little closely. If the inner petals of a well developed bloom of the double Cherry are torn away it will be found that almost invariably a tiny leaflet occupies the centre of the bloom. This little leaf, it will be noticed, is exactly in the place of the solitary carpel, which is, of course, the distinctive feature of the tribe. A comparison of this leaf with a perfect carpel of the Cherry is interesting. It is easy to see that the two sides of the small leaf represent the ovary, whilst the elongated process can be none other than the style.

Later on in their history the carpels often develop into very leaf-like organs. This is the case in the seed vessel of the Pea, where it is discernible that the two sides of the pod are not unlike the lobes of a leaf joined together by a midrib. A rare and most suggestive monstrosity is sometimes to be seen in the case of the Pea pod. This comes about when the ovules fail to develop and the two sides of the pod do not close together in the normal fashion. On such occasions the lobes of the pod are more than ever leaf-like, not only in appearance, but actually in structure. It is possible to see small projections on the borders of this curiosity (which may be called the carpellary leaf) that show where, under ordinary conditions, the ovules would have been.

In the present and the preceding article all the different parts of the typical flower have been detailed in the order in which they occur when a start is made from the outside and one proceeds inwards. This method has been carried out as the simplest way of dealing with a rather difficult subject. To the reader who has followed the argument from the commencement the connection which each part of the flower has with the other is very apparent. In every instance one is brought back either directly, or through some other organ, to the leaf as the origin of the whole flower. That the leaf was in existence prior to the blossom is, of course, an indisputable fact, for whilst flowering plants can persist without blooms, they could not live at all without foliage or its equivalent.

In the centre of each Double Cherry bloom is to be found a small green leaf.

Concerning the very important question as to the order in which the various parts of the flower were evolved there has been a good deal of controversy. A moment's consideration will be sufficient to show that the first part of the flower to be formed could scarcely have been the calyx, the next the corolla, and so on. It is almost impossible to conceive that these particular organs, which, after all, are only appendages, even though they serve a useful purpose, should have been formed in advance of the essential organs. The main object of the brightly-coloured corolla seems in every case to be as a means of advertising the presence of the stamens and pistil to the special agent which will undertake the process of fertilisation. Flowers with petals, but lacking the organs of reproduction, are, of course, unknown in Nature, whilst there are many instances where the stamens and pistil are in evidence, but in which the corolla is quite absent. So that the well-nigh inevitable conclusion is that the stamens and the pistil were developed from the leaf first of all, the corolla and its envelope, the calyx, later on. Thus we must regard the strange midway organs which have been noticed in the case of the flower of the Water Lily rather as degenerate stamens than as advancing petals.

The subject is such a profound one that it is not possible to do more than to hint at the wonderful process whereby the different parts of the flower as we see it to-day have been developed. One cannot help

A rare monstrosity of the Common Pea, where the lobes of the pod have [failed to close together.

being impressed with the manner in which at every point one is brought face to face with the immense importance of the leaf in the economy of the plant. In the leaf is situated that basis of the plant life—protoplasm, present in the specialised form of chlorophyll. It is from the base of the leaf stalk in the majority of cases that every extension of the plant arises. Very many plants can, under certain conditions, give rise to fresh plants by means of their leaves, whilst some of the lowlier forms of green vegetable life never increase in any other way than by a process of leaf cell extension. Under these circumstances it will be admitted that we shall not be far wrong in regarding the leaf as the most important organ of the plant.

Our Own General Election.

THE results of our call for opinions has not developed any such remarkable surprises as those in the political world.

Though our thanks are due to many hundreds of readers who have kindly returned the Ballot Cards duly filled in, we are slightly disappointed that a larger proportion of our electorate did not record their votes. It may be due to laxity in the canvassing; but, perhaps, the fact is not of importance, since it must be presumed, as in the political elections, that those who did not poll are contented to leave the conduct of affairs in the hands of those in authority, without any very special wishes as to future policy.

The cards must be carefully gone through before we can definitely decide on any change of policy, but a cursory glance at them seems to show that most readers are quite satisfied with the arrangements now in vogue.

The Interior of the Earth.

Radioactivity and Volcanicity.

IN an article on "The Interior of the Earth," which appeared in "KNOWLEDGE AND SCIENTIFIC NEWS" for last month, it is stated:—

> "The liquid substratum consists of a mixture of *fused* rock and a *dissolved gas* (in all probability hydrogen)."

It may assist the theory somewhat if an explanation were offered for the existence of hydrogen at such low depths and so intimately associated with the fused rock.

Among the many and wonderful properties of the radioactive elements, one of the most recently discovered is that these substances slowly effect the decomposition of water into its constituent elements, hydrogen and oxygen, *in the exact proportions, by volume, necessary for the re-formation of water.*

This discovery must be considered in conjunction with two well-established facts, viz.:—

(1.) Water is capable of percolating to very great depths in the earth's crust—the evidence from hot springs is a sufficient testimony to this. (In the vapours from which, radioactive emanations are *always* present), and

(2.) Radioactive minerals are to be found in rocks, which, although sometimes met with at the surface, possess all the characteristics of having a deep-seated origin.

It must follow, then, that the water, as it percolates between the interstices in the rocks, or even between the composing crystals (for it is very imperfectly understood by what means water *can* reach such depths), is decomposed into hydrogen and oxygen.

The characteristic property of the latter gas affords a ready and sufficient explanation of the fact that little or no free oxygen ever appears at the mouth of an active volcano or ever issues from the surface of a hot spring.

The suggestion may even aspire to explain the universal existence of oxygen in combination with all the elements composing the earth's crust.

With respect to the hydrogen, that which has been liberated nearest to the surface of the earth may conceivably make its way up again into the atmosphere; that which became free at lower depths may find its way to a point of weakness (such as would be offered by a volcanic area), and make its escape in a more sudden and disastrous manner; while the hydrogen that was formed at the lowest depths, finding it impossible to escape, owing to the pressure above and other causes, might possibly become incorporated with the rock in its vicinity in such a way as to supply the *dissolved gas* which Fisher's theory requires.

Fisher assumed the existence of a liquid substratum (beneath the earth's crust), which is saturated with gases, and, therefore, expansible. If the capacity of molten rock for dissolving gases is similar to the solubility of certain gases in water, then there would be no tide in the substratum which would affect the level of its surface or cause any rise or fall of the overlying crust, which proves, what Fisher maintains, that there are no terrestrial tides.

If it be admitted that the interior of the earth is either molten throughout or liquid to a certain depth, and then a solid nucleus, then it must follow that terrestrial tides *do* exist. But the most weighty evidence on this point is not that supplied by actual observation, but by calculation based on the above assumptions. B. I.

Astronomical Observation and Spectacle Wearing.

By S. L. SALZEDO.

MANY persons are no doubt under the impression (as the writer was for many years) that the wearing of spectacles is a complete and effective hindrance to the use of a telescope. This may result in the loss to astronomy of people who might develop into enthusiastic workers. In order to demonstrate the error of this view it is sufficient to deal in turn with the various defects of vision for which spectacles are prescribed, and to show how they are overcome.

The defects of vision which are corrected by means of spectacles are four in number; they are:—

1. Myopia (short sight).
2. Hypermetropia and presbyopia (long sight and old sight).
3. Astigmatism.
4. Muscular imbalance.

In myopia, hypermetropia, and presbyopia the only purpose and effect of the lenses prescribed is to supplement the defective focal length of the eye. The telescope, however, is able to supplement the focus of normal vision by a very large amount in either direction, *i.e.*, to shorten or lengthen the focus, thus performing the very same function as the glasses worn before the eye. These defects may, therefore, be completely disregarded.

Of the remaining two visual defects, No. 4, that of muscular imbalance, is a matter of defective co-ordination of the visual axes of the *two* eyes, and is entirely inoperative where *one eye alone* is used alternately.

The fourth defect of the astigmatism is due to defective sphericity of the eye, and is corrected by means of a lens ground to form a section of a cylinder, either in combination with any of the other lenses or alone.

This defect is *not* susceptible of correction by the optical structure of the telescope. It needs to be dealt with specially. As the writer is fortunate enough to possess three of the above defects in combination (hypermetropia, muscular imbalance, and astigmatism), he has been compelled to devise a method of correcting the astigmatism likewise. This may be done very simply:

Having ascertained the power of the cylinder required, have an ordinary sunhead carefully fitted, in place of the dark glass, with a cylindrical lens of the required strength. The axis of the cylinder should be indicated by a line on the outside of the cap for the purpose of adjusting to the astigmatic axis of each eye. In most cases the astigmatic axes of the two eyes are different. It would, therefore, be preferable to have two lines cut upon the outside of the cap in such a way that when one line is vertical the axis of the glass is adjusted, say, to the left eye (this line being marked "L"), and when the other line marked "R" is vertical the cylindrical axis is adjusted to the astigmatism of the right eye. This cap may be screwed on to the telescope like an ordinary sunhead, or may be fitted into the screw flange of the eye-piece and the lines brought to the vertical as required.

For this purpose it is best to give the optician the oculist's prescription, explicitly stating, however, that it is only the *cylindrical* glass which is required.

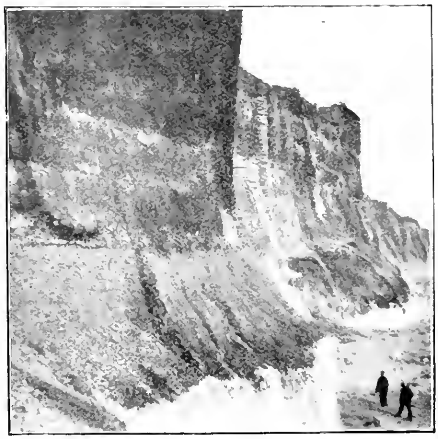
It is perfectly evident, therefore, that no purely optical defect need stand in the way of the enjoyment by all those who desire it of the many delightful hours which may be yielded by the examination of the heavens.

Coast Denudation in England.

By EDWARD A. MARTIN, F.G.S.

IN 1867 the total area of England, excluding the foreshore, and the area covered by the tides, was 32,590,397 acres. In 1900 it had diminished to 32,549,019 acres. In the intervening 33 years, England had diminished in superficial area by 41,378 acres. These are figures which have been furnished by the Board of Agriculture. Taking an acre of land to be worth £25, this would imply a capital loss to the country of over £1,000,000. The total denudation of the land between the years mentioned is in reality greater than shown, since, in the return for 1900, are included the gains which have accrued in those comparatively few coast-line areas where the sea has actually receded.

A similar loss of land had, of course, been going on for centuries prior to the period covered by the return in question, and there are not many parts of the country where there do not exist local records and traditions of former much greater extensions of the land.



Brighton Cliff Formation, Resting on Chalk.
(*A*) Rubble-drift. (*B*) Raised Beach.

A glance at a geological map of England is sufficient to show at once why it is that some parts of the coast have suffered more greatly from erosion than others. Generally speaking, the more ancient the rocks which form the coast, the more they are able to withstand the denuding action of the waves. Thus we have on the one extreme the iron-bound coast of Cornwall, with its ancient palæozoic rocks, on which the waves have but little effect, and on the other the boulder-clay areas of the Norfolk coast, and of the south-eastern portion of the Yorkshire coast.

During the last two years efforts have been made with a view to call public attention to the loss by coast-erosion, and if possible to obtain national sympathy for the land-owners who have suffered. Individual efforts at groyning and breakwater building are comparatively few, outside the areas of the larger coast-line towns, and with the present value of the land to be salved there is little more to be expected. Mr. A. J. Sauer has recently shown how useless it is to expect much in the way of private enterprise. Taking an acre of land to be worth £25, or about 1¼d. a square yard, and reckoning that for every lineal yard of coast washed away each year two square yards are lost, the total loss would be 2½d. per yard of coast. Defence works vary considerably in cost, but a fair average works out at £10 per yard of coast. Interest on this at 2½ per cent. would amount to 9s. 6d. a year, and with this cost it would be possible to save per annum twopence-halfpenny worth of coast. It is scarcely to be expected that such an unremunerative expenditure would be incurred either by private land-owners or by the State itself. Only where the land in danger acquires a value in consequence of the growth of population do defence works become of a remunerative nature.

The causes of this denuding action of the sea are to be found in purely geological considerations. Ever since the time that this country rose for the last occasion out of the sea, a sea covered with the *débris* of the ice-sheet, which was then commencing to pass away, she has been subjected to the battering-ram action of the tides, and wave-action brought into play thereby.

There is a general agreement amongst geologists that at the time of the uprise of the country from the glacial sea, it rose to a somewhat greater height than that at which it now stands. The evidence on which this is based is formed for the most part in the existence of submerged forests in many parts of the coasts, although on the face of it the existence of a single buried forest is insufficient evidence on which to base an opinion that the part in question at one time stood higher than now. But taken as a whole it may be assumed that England has been subjected, since the growth of these post-glacial forests, to a subsiding movement, and this has brought the areas in question below the level of the sea. When that movement of subsidence ceased, we have nothing to show. So far as existing records show, we can only suspect a movement of subsidence in the historic period, but this lacks positive proof.

For the causes which have resulted during very many years in the gradual wastage of our coasts, we must, therefore, look entirely to marine and aerial denudation, acting as a rule together. In the case of cliffs having a much-jointed structure, or with vertical and diagonal joints and fissures, aerial denudation is as important a geological force as marine. The chemical action of percolating rain in loosening the constituents of some rocks, and the splitting action of such waters under the influence of frost, all tend to degrade the face of a cliff, and the tale is taken up by the tides, by whose action the disintregrated material is borne away to sea.

But in low-lying coast-lines, where the action of frost is slight, or on those shores where, owing to the nature of the material of the cliffs, chemical action is almost entirely absent, there marine denudation is wholly responsible for the loss of acres of land, and where the shores are so low as to be subject even but rarely to flooding, the area covered is at once rendered useless for agriculture, and so receives even less attention than it formerly had, in the direction of protection against the inroads of the sea. Thus, in the end, it becomes permanently lowered by further denudation, until its surface is beneath the level of the sea. But marine denudation, simply, may be the cause of many a noble cliff crumbling away. It is estimated that many of the prevalent storms which arise in the North Sea show their effects on our eastern and north-east coast in waves which beat upon the cliffs with a force varying between two to three tons to the square foot. A change in the nature of the strata in a cliff, owing to the strata dipping at an angle in a direction parallel with the coast, will be sufficient for such a force to find a suitable lodgement on which to play with success. Or it may result in undermining, until the upper parts of a horizontally stratified cliff may project several feet beyond the base of the cliff. In that case a period will be soon reached at which the overhanging portion will fall. Then marine action, which commenced the process by its undermining action, will complete the work by bearing away the fallen material, and redepositing it elsewhere. But such redeposition seldom results in the formation of land elsewhere. It may shoal up a sea, but only to a certain point. Without any subsequent submarine upheaval, the *débris* of the land so denuded rarely results in dry land. Without a counteracting uprise, the tendency of the land is towards complete disappearance beneath the sea. It is not always realised that were the de-

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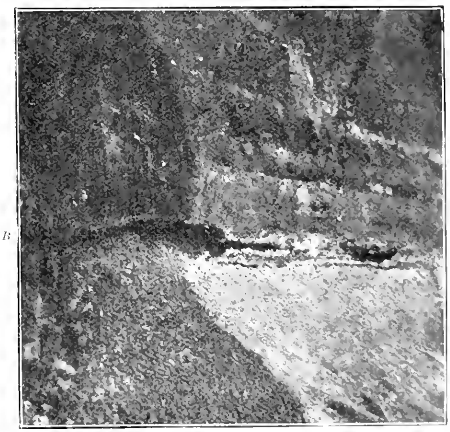


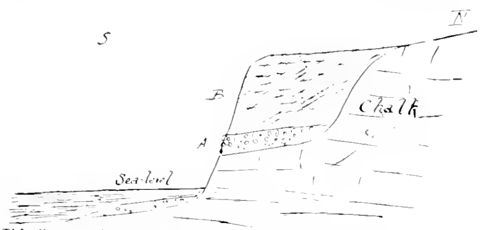
The Raised Beach, showing Cave-like Holes (*B*) where the Loose Larger Stones at the top have fallen away.

nudation of the land to go forward unchecked, the result would be the complete disappearance of our land areas. In fact, so great is the preponderance of sea-areas that were the earth completely spheroidal, there would be a universal ocean two miles deep. Fortunately, as geology teaches us, time after time the results of the degradation of the land have been rendered nugatory by upheaval.

But in our own country, at the present time, we have no decisive evidence that either upheaval or subsidence is going on. Denudation of our coasts proceeds with no check placed upon it by natural causes. It will become a serious question as to whether artificial protection will not sooner or later become an imperative national concern.

The last movement of upheaval which England underwent was that which on our south coasts elevated the raised beaches which are there found, and even though the existence of buried forests seems to show a subsequent partial downward movement, this was not sufficient to counteract the former upward movement. The result is seen in the raised beaches and rubble-drift formations which have from time to time been described. The Brighton cliff formation is one of the best examples of this kind. The formation occurs at the east end of the town, and owing to its nature is liable to constant falls. Thus fresh sections are frequently being exposed. At the present time, the lower portion of the cliff consists of about ten feet of chalk. Upon this chalk rests about eight feet of beach. This beach was sorted in the same way that modern beaches are sorted now, so that we find upon the chalk a good deal of sand and small pebbles, and these increase in size upwards, until large flint boulders complete the higher portions of the beach. Although the beach is mostly of flints, it also contains a few rolled granite boulders and rounded lumps of red sandstone.

Owing to lack of cementing material in the beach, it is constantly falling on to the lower beach, and cave-like holes are formed. Then, in the course of time, the rubble above it, having lost its natural support, falls on to the beach below, and is rapidly carried away by the sea. The rubble forms the remainder of the cliff.



This diagram shows that the Channel formerly extended further in a northernly direction than now. (A) Raised Beach. (B) Rubble-drift. Brighton Beach.

It is of a brown colour, and contains numerous rounded and sub-angular pebbles of chalk and flint, varying very much in different parts. It was in this rubble-drift that Mantell found remains of *Elephas primigenius*, and hence the name of Elephant Bed sometimes applied to it locally. *Rhinoceros tichorinus*, *Cervus elaphas*, and *Hippopotamus major* were also found.

The nature of the animal contents shows that the time of its formation (Pleistocene), although geologically of fairly recent date, was yet far removed, if one counts by years, from existing times. The upward and then the partial downward movements which have since occurred, have now completely come to a standstill, but the denuding action of the sea continues, and this in so porous a material as the rubble-drift is aided by sub-aerial denudation. Where the coasts are formed entirely of chalk, erosion by the sea is not so marked, although it is far from being negligeable. But when we look at our eastern coasts, and consider the fragile nature of the material of which our cliffs are there formed, we almost wonder that coast erosion has not been more marked than it has been. The boulder-clay cliffs of south-eastern Yorkshire render that coast peculiarly liable to denudation. The inlet of the Wash was brought about by the friable nature of the strata when once the chalk had been breached. The glacial and crag cliffs of Norfolk and Suffolk, and the London Clay cliffs of Essex all afford yielding material to the inroads of the sea. On the north of Kent, the London Clay is constantly slipping into the bed of the sea, together with other loosely-accumulated material of tertiary age.

When one looks at a map of our country, one cannot help being struck with the fact that it is not a little remarkable that the great bulge of the east coast is just in those parts where the coast-line is least protected. Our oldest and most indurated rocks are, on the whole, on our west coasts. In general our strata dip from west to east, and this has been brought about by a tilting movement, which has exposed the edges of upturned rocks of older date, as one proceeds westwards. The coming of the North Sea may have been materially assisted by this movement, and since its advent, the sea has steadily continued to work backward, until, in-

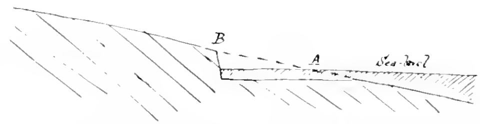


Diagram showing the progress of coast erosion and the formation of cliffs on the East Anglian Coast: dip greatly exaggerated.

stead of breaking on a shelving strand, as it would have done at A, it has, by ceaseless erosion, produced the cliff at B. This is, in effect, the condition in which we find the cliffs in East Anglia. As a matter of fact, the very existence of sea-cliffs is evidence of erosion, whether the cliffs be formed of igneous or sedimentary materials; but to go back to the time when that erosion commenced, one must go back to that time when the country last emerged from the sea. The task which engineers have now set themselves is to protect the shores as they now are, and from a discussion which took place at a recent meeting of the Institute of Civil Engineers, it seems to be generally accepted that defence works have, as a rule, been pushed too far sea-ward, as though to reclaim some of the land which the sea had already swallowed up years ago. The result has been disastrous to the unprotected areas in close proximity. To mention two instances only, we find the scouring out of East Wear Bay largely owing to defence works at Folkestone Harbour, and the rapid succession of falls of the cliffs at East Brighton are directly owing to the scour of the tides after passing the town's defences. There has been too much of the desire on the part of the local authorities of those areas which could afford defensive works to benefit at the expense of those owners whom it would not pay to make great outlays. It is well that engineers recognise this, since in their individual capacity they are responsible for the erection of all such defence works.

Roman Coins at Hull.

THE Municipal Museum at Hull has recently acquired an extensive and valuable addition to its collection of local Roman, &c., remains.

It consists of the life work of a somewhat eccentric character, Tom Smith, of South Ferriby, locally known as "Coin Tommy."

The specimens are principally of Roman date, and include over 2,000 coins, nearly 100 fibulæ of a great variety of patterns, several dozen buckles, pins, dress fasteners, ornaments, strap ends, bosses, spindle whorls, armlets, spoons, beads, objects of lead, &c. Amongst the fibulæ are two of altogether exceptional interest, as they bear the maker's name upon them (AVCISSA). Only two examples of brooches marked in this way have previously been found in Britain (in Somerset), though they are recorded in France, Germany, Italy, &c.

There is also an extensive collection of pottery, including many vases, strainers, dishes, &c., in grey ware, as well as many fine pieces of Samian ware.

Photography

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Reversal and Re-Reversal.—It was about five and twenty years ago that M. Janssen observed, when photographing the sun, that, with the particular sensitive plates he was using, an exposure of from one to two hundred thousand times the suitable exposure for an ordinary image gave on development a positive instead of a negative, and that by increasing the exposure to about a million times the image was again reversed, though with a considerable diminution of contrast. These observations, expressed in the simplest form, indicate that a gradually increasing exposure followed by development, will give at first an increasing darkness of deposit, then a diminution of density, followed by another, though less marked, increase of density; and there seems to be some evidence that this alternating rise and fall of density resulting from a continually increasing exposure, might go on until the differences were too small for observation if interfering circumstances did not step in to vitiate the experiments. It has further been suggested that the image utilised in ordinary negative making is not the first result of the action of light, but is preceded by a similar alternating action to that which seems to follow it. If this is so not only is the result of the continuous action of light of an alternating character, but the maxima first increase and then diminish, the effect passing, doubtless, into changes of a different character.

It is easy to prove the increase of density with increase of exposure as in ordinary negative making, and then a decrease as in the reversal resulting from over exposure, but to get further than this is, experimentally, so difficult that many have tried and failed, and not a few have, therefore, doubted Janssen's original observations, and believe only in one increase followed by one decrease in density. What appears to be a definite proof of a second increase of density has lately been supplied by M. Adrien Guébhard, who, in the *Comptes Rendus* (CXLI., 559), gives a reproduction of the result of one of his experiments. A Lumiere film was exposed to daylight for forty-four days last August and September, including only nine dull days, under a graduated screen made of white paper arranged in from one to twenty-two thicknesses, covered with a cut-out black paper screen. The film was then developed for five minutes in an ordinary metoquinone developer. Confirmatory results were also obtained on Eastman Kodoid films.

The total exposure of forty-four days may seem excessive in dealing with a series of only twenty-two exposures, but the exposure durations have to be in a geometric series. An initial exposure of approximately one second in a series of twenty-two, if each is double the preceding, would require about the time stated for the last. The impossibility of confining the light action to the part required is a very great difficulty in such an experiment, because of reflection within the film. For any who wish to test the matter for themselves, and reliable confirmation of the results obtained with an extension of them as far as possible would be very welcome to all interested in the study of pure photography, I would make the following observations:—

A pure bromide emulsion (free from iodide) gives a much more quickly reversible image than the ordinary mixture of bromide and iodide. One considerable disadvantage in the use of commercial preparations is the uncertainty as to what they contain. Some plates now on the market are not simple emulsions of silver salts, and it seems at least probable that even the makers do not know what they contain, although, of course, they know what they use in their preparation. But still, experiments with commercial plates are interesting and may be useful. To avoid the interference of the long exposures with the comparatively short exposure effects, I would suggest getting the shorter exposure by means of a graduating device, such as what is commonly known as a Spurge's sensitometer, and for the longer exposures using separate parts of the sensitive material each quite isolated from the other by being contained in a separate compartment of a multiple-cell box, or one of a number of small boxes. The exclusion of vitiated air, the avoidance of complications due to temperature changes, the results of comparative blank experiments to discover any interfering circumstances that may be present, the distinction in the result between printing-out and development effects, and other such matters must, of course, be taken into consideration.

Shading the Lens.—The importance of so shading the lens, especially when working out of doors, that extraneous light is excluded from the camera, is not recognised now as it used to be, and never was generally recognised as it ought to be. If the glass of the lens were perfectly transparent, its surfaces perfectly polished, the interior of the mount of the camera perfectly non-reflecting, and the air perfectly free from motes, there would be, perhaps, no advantage in shading the lens; but such conditions are impossible. The hood generally found on old lenses, but often not on new ones, is a little better than nothing. Years ago some photographers made large conical hoods, almost reminding one of small gramophone trumpets, and these were used even in studios with advantage; but this is not the kind of thing that will best serve the purpose. It is obvious that the shape of the opening at the outer end of a large hood or shade should correspond to the shape of the plate or that part of the plate that is to receive the desired image. If a light bellows could be attached to the camera front so that it could be opened out to extend a few inches in front of the lens, and carry at its outer extremity a screen with an adjustable rectangular opening in it, the shading of the lens would be ideal. This principle, but without the possibility of adjustment, may be easily carried out in those hand cameras in which the lens is within an outer case. The opening in the front of the case may be so made that while the plate is fully illuminated, all the light that can be safely cut off is prevented from entering the camera.

There is also advantage in using a camera made to carry a larger plate than that used and in fitting lenses into mounts of a larger diameter than is necessary just to hold them, as in both cases the reflecting walls are further away from the path of the light being utilised, and the reflection is reduced. In spectroscopy and photo-micrography these matters are of considerable practical importance.

The Optical Projection of Opaque Objects.—A piece of apparatus that deserves to be more widely known is the "Picture Postcard Lantern," made by Messrs. W. C. Hughes and Co., of Mortimer Road, Kingsland. It consists of a well-made and capacious Russian-iron lantern, within which are two incandescent gas burners, one on each side, that illuminate the card held in a carrier at the back, and a lens in the front of the lantern that projects the image on to a small screen three or four feet away. While originally meant for picture postcards, it will give an enlarged image of any paper print or diagram, or of the page of a book without injuring the book in any way. The image as given directly is, of course, laterally inverted, but where this is a drawback, as in the case of figures or letters, this is easily obviated by fixing a piece of silvered plate glass (thin patent plate silvered on the back serves well and is easily obtained) in front of the lens and receiving the reflected image on the screen. In addition to the obvious uses of such an apparatus, one can, by its means, judge at once from a small print whether an enlargement of it would be of advantage, and it will often save the trouble of making a lantern slide and arranging an optical lantern.

The Glastonbury Grace Cup.

PEG-TANKARDS are of the Saxon period. A fine specimen of Anglo-Saxon work, formerly belonging to the Abbey of Glastonbury, is now in the possession of Lord Arundel, the noble owner of Wardour Castle. This old relic is known by the name of the "Glastonbury Cup," as tradition says it was carved out of a piece of the Holy Thorn on Weary-all Hill, when Joseph of Arimathea rested and planted his staff, which, like Aaron's rod, "budded and flowered." It is also known as the "Grace Cup," and the old belief still exists that it is

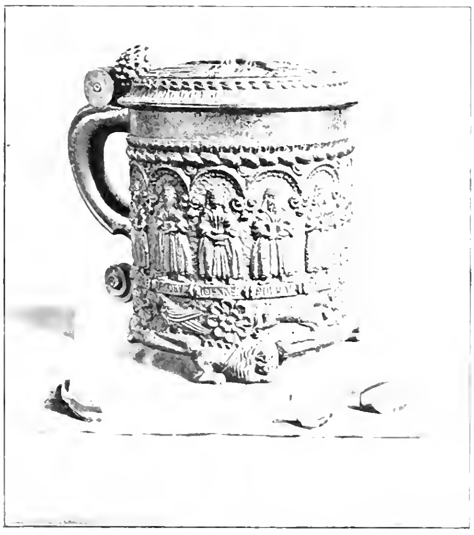


Photo. by W. Tully, Glastonbury

Grace Cup in Wardour Castle.

the original Glastonbury Cup which was used as a Grace Cup after meals in the refectory by the monks of the Abbey. It is made of wood, and rests on crouching lions, the bowl being carved with the twelve Apostles. On the lid, the Crucifixion is carved, with the Virgin Mary and St. John. The Cup holds two quarts, and originally had eight pegs placed one above another inside, dividing the liquor into equal quantities of half a pint each.

The Rule for the Infinity Focus.

By DR. G. H. BRYAN, F.R.S.

MOST instructions sent out with cameras contain somewhat dogmatic statements as to the distances at which objects are in focus with a certain stop. It is surprising that so few people know the very simple rule for such matters.

Let a camera be focussed for "infinity," that is, for parallel rays (as in the cheaper box cameras), and let it be directed at a near object. Take two points on the object, whose distance apart is equal to the diameter of the stop. Then it is just possible to draw a couple of parallel rays from the two points to the lens, and these extreme rays will converge to the same point on the negative. If the points are further apart, no rays from one are parallel to rays from the other, nor do they consequently converge to the same point on the negative. We thus have the following result:— In a fixed focus camera the impressions produced on the plate or film by two points of a near object will overlap if the distance between the points is less than the diameter of the stop. If the distance between the points is greater, the impressions on the plate will be distinct.

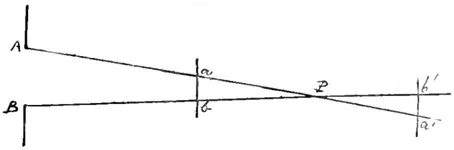
In most cameras the stop is placed between the lenses. On looking through the front lens the stop appears slightly magnified, and a little simple reasoning shows that it is this magnified diameter, not the actual diameter of the stop, that must be taken.

For instance, if, on looking into the lens, the stop appears to be half an inch in diameter, no objects less than half an inch apart will produce separate impressions; half an inch is, therefore, the limit of size of the details which can be shown in the photograph. It makes no difference whether the objects are near or far away. If they are near, details below half an inch in size may be large enough to appear blurred on the negative, if they are far off, such details may be unnoticeable, but if the negative be enlarged to the same size as before they will present the same appearance as before, other circumstances being left out of account.

Another consequence of the rule may be noted. With a lens of four inches focus, the limit of detail will be one inch for stop f/4, and $\frac{1}{4}$ inch for stop f/16. With a lens of one inch focus the limit of detail would be $\frac{1}{4}$ inch for stop f/4, and 1-16th inch for stop f/16.

Suppose, then, that instead of taking quarter plate negatives with a four-inch lens, we were to take negatives measuring about 1 inch by $\frac{3}{4}$ inch with a lens of one inch focal length and a corresponding stop, and suppose we were to make enlargements of the same size from both negatives. Then the enlargement from the smaller negative would show four times the detail in focus at all distances; that is, details of $\frac{1}{4}$ inch would be in as good focus in the enlargement of the smaller negative as details of one inch in that of the larger. By carrying a very tiny camera about in his watch pocket and trusting to enlarging, a photographer might be practically independent of focussing even for very near objects indeed, but for the fact that imperfections and coarseness of grain in the negatives would be enlarged correspondingly.

The corresponding rule for a camera focussed for a finite distance is best shown with the aid of the accompanying figure. If A B represents the stop or its magnified image as seen in the front lens when focussed on a point P, at any given distance, details at any other distance will be separated in the photograph if



their distance apart exceed the breadth of the cone A P B at that distance. For instance, *a b* and *a' b'* show the distances apart of points when the impressions they produce in the photograph just cease to be separate.

I found these rules of great use during the recent visit to South Africa, and the results obtained were in complete accordance with them, especially when other conditions were taken into account.

CORRESPONDENCE.

Green Flash at Sunset.

I would call attention to a phenomenon of atmospheric refraction frequently observed, but of which very little has been published. I refer to the green flash seen in clear weather as the last ray of the setting sun disappears. I observed this one evening in the N. Atlantic last month, and I also saw it in the N. Atlantic in October, 1898; on this last occasion I watched Venus setting a little later, but though the planet turned red occasionally as it approached the horizon, it did not flash green at the last moment. I have, however, seen stars set with a green flash, but rarely.

The phenomenon is noticed in "KNOWLEDGE" for April, 1889, p. 126, here the colour is given as blue: in "Nature," March and April, 1890, pp. 495, 538; and in R.A.S. notices, May, 1901. In these notices the writers appear to hold different views as to the cause. In Elementary Meteorology, by Professor W. M. Davis, p. 50, it is stated that after sunset every solar beam will be broken into a short vertical spectrum; is this the explanation? If so, why should the last flash be green (according to some accounts, of a remarkably vivid green)? I would like to see the matter worked out.

J. P. MACLEAR.

Chiddingfold, 19th Dec., 1905.

[Admiral Maclear's letter opens up the subject which has for a very long time formed a topic of discussion, especially among voyagers at sea. We have always held the belief that the phenomenon is solely due to the optical effect, so well known, of a complementary colour appearing on the withdrawal of any very brightly coloured object. If you look at the sun and then close your eyes, a brilliant green image will be seen.—ED.]

The late Prof. Howes.

WE are requested to announce that the endowment fund now being raised for the family of the late Professor G. B. Howes F.R.S., will be closed shortly, and all intending contributors are asked to send their contributions without delay to the Treasurer, Mr. Frank Crisp, at 17, Throgmorton Avenue. London, E.C.

Influenza and the Weather.

To the Editor of "KNOWLEDGE AND SCIENTIFIC NEWS."

SIRS,—In your issue of November there was a most interesting article from the pen of Mr. A. H. Bell *re* the above subject. It is a subject of the utmost importance to the public, for a ravage of influenza has in its tiny germ as deadly a killing factor as shot and shell in a big war. That Mr. Bell is perfectly right, most doctors who read his article will perfectly agree. Most will also see in the much abused east wind one of Nature's best antiseptics, so that instead of being the sower of disease we would rather look upon it as a trying but invigorating friend. True, it may be a dread to the very young, the very old, and to the feeble and confirmed invalid; but to the great mass of mankind it certainly does not deserve all the scape-goatish epithets flung at it.

From personal experience I can corroborate every word written by Mr. Bell, for it has been my fortune, or misfortune, to contend with more than one attack of severe influenza whilst practising in England.

In a large country practice I found that in no case did influenza spread except by the contact of the healthy with the affected.

Farmers and their wives had it first, then their families, lastly their servants. Time after time noticing that those who did the marketing were the first to be struck down, convinced me that influenza chiefly spread by contact.

In the Blue Book which Dr. Franklin Parsons drew up for Parliament when the first severe visitation of influenza some 20 years ago visited Great Britain, there is a report of mine bearing out the opinions so clearly set forth by Mr. Bell in his article in "KNOWLEDGE." In a conversation I had with Dr. F. Parsons he, too, was fully convinced that climatic changes had little to do with the spread of influenza, and in coming to that conclusion he had his own observant mind guiding him, as well as the experience of others.

I am, dear Sir,
Yours truly,
T. PICKTHORN THOMSON,
C. S. *Dufles*,
Suez, Egypt.

Venom of Spiders.

TO THE EDITOR OF "KNOWLEDGE."

SIRS,—I have read with great interest Mr. C. A. Michell's letter relating to the venom of spiders. I have always had great interest in this subject, and have studied it for many years.

When I was a boy at school I was very fond of natural history, and used to spend much of my spare time collecting specimens. One day I succeeded in catching a very large black spider, but unfortunately I did not notice the variety. Having nowhere to put it, I placed it in a box containing two frogs. To my surprise next morning I discovered that one of the frogs was dead and the other very torpid, and succumbed in a few minutes. The spider was quite lively, and when disturbed with a straw attacked it furiously.

Happening to mention this fact to our old gardener, who had a great reputation in the village for his knowledge of wild things, he declared that the bite of a spider was fatal to all small creatures, but only during a certain part of its existence. Wishing to prove this I tried the next night with another frog. In the morning the frog was dead, but the spider had unfortunately escaped. I tried several times after this, but these were the only cases in which the frogs were killed. I shall be much obliged if any of your readers can inform me to which variety my spider belonged. I have never since seen one like it. The points that struck me most about it were its great size, its broad, smooth back, and the orange stripe along the lower side of its body.

F. T. Z. D.

The Elms.

Answers to Correspondents.

Altitude of the Sun. In the note in the January number the declination should, of course, read 23° 3′ 28″ instead of 28° 3′ 28″, which alters the calculation.

B. Lomax. "*Baily's Beads.*" Just before a total eclipse of the sun, and when but a very narrow rim of the sun is visible, this thin line suddenly becomes broken into detached spots of light caused by the irregular (mountainous) surface of the moon. This phenomenon was first noted by Francis Baily in 1836.

J. H. The resistance of the air to a surface moving against it is not quite as you put it. The formula should read:

$$P = V^2 X$$

when P = Pressure in lbs. per square foot.
V = Velocity in miles per hour.
X = A constant which varies according to different experimenters, but may be taken at about ·003.

It is very generally supposed that a bird gains a certain amount of lift even during the upstroke of the wings. There are, unfortunately, a large number of inventors anxious to obtain funds for constructing their models, but, considering the very great amount of time and money which, without doubt, must be expended before a successful flying machine can be constructed, our advice to those not having such commodities at their disposal is to leave the matter alone.

REVIEWS OF BOOKS.

Nebula to Man, by Henry R. Knipe (Dent and Co.; price £1 1s. net).—This is a fine work—original, poetic, and sublime. It treats of the history of our planet from its very birth, and the evolution of life-forms down to man. Such a subject, so vast in its magnitude, yet so hypothetical in its nature, is appropriate to verse, and accordingly this history of an eternity forms a great poem, descriptive of what we know, or presume we know, of ages long gone past. The interest and attractiveness are greatly added to by the profusion of well-designed and well-executed illustrations. Many of them are coloured plates, and represent various scenes in bygone times, from views of nebulæ and landscapes in the different geological periods, queer denizens of the earth and waters, down to prehistoric man. Quite a number of artists have contributed to this interesting collection. If the whole is naturally to some extent fanciful, the facts introduced are well authenticated, and the notes at the end of the book supply references to the sources whence these facts are culled. To give some idea of how such a subject is treated in verse, we may quote a few of the opening lines, and if the poetry be not of the highest order, it is, at all events, well-worded and pleasing—

> A glowing mist, through realms of space unbounded,
> Whirls on its way, by starry besits surrounded,
> Dim is its lustre, as compared with theirs,
> And more the look of stars dissolved it wears.

The following, too, may exemplify some of the apposite ideas included—

> Perchance descended from those gauze-winged flies,
> That flitted joyous 'neath Devonian skies,
> In places now some butterflies are seen,
> Gay colours bringing to the sombre green.
>
> * * *
>
> How great and varied, Nature, are thy powers!
> Those monster reptile forms, those flying flowers!
> And can it be that in some far back age
> In one life-form both had their parentage?

We hope this is a correct quotation, although there is an evident misprint in the book in the fifth of the lines quoted above.

The Uses of British Plants.—By an oversight we omitted to mention in our last number that this book is by the Rev. Prof. G. Henslow, M.A., and is published by Lovell, Reeve and Co.; price 4s. 6d. net.

The Nature and Origin of Living Matter, by H. Charlton Bastian, M.A., M.D., F.R.S., &c. With 245 illustrations from photo-micrographs. Medium. 8vo. (Fisher Unwin; 12s. 6d. net).—Dr. Charlton Bastian has produced a work replete with interest. The views expressed, and the conclusions drawn, are not seldom unorthodox; yet, the author has great respect for the opinions of others, in spite of—and not unnaturally—a decided leaning towards his own, missing no link in the chain of reasoning which will convince the reader of their soundness. The earlier chapters will repay attentive perusal, as leading up to what might be thought the more fascinating problems ot "Spontaneous Generation" and the Heterogenetic origins. Dr. Bastian rightly lays stress on the "Uniformity of Nature," as the basis of the hypothesis of evolution, for without this "Uniformity" our knowledge of the past, and insight of the future, would be indefinite and futile.

Certainly, Aristotle did not hold this view, nor could it be expected that he should, since it is time alone that has driven "Chance" and "Spontaneity" from their position in nature to be replaced by law and order.

Evolutionists generally are not at one with the author's more advanced views on the occurrence of Archiebiosis. The belief of the majority is that living matter came into being once only, and that in the distant geological past. Dr. Bastian has Haeckel and Carl Nägebi with him in the belief that Archiebiosis has been repeated times without number, and also that it arises *de novo* now.

How the formation of organic material from the inorganic is, or was, brought about may remain a profound mystery, whichever view be held. It must be admitted that Dr. Bastian's researches into the natural origin of living matter, from their inherent difficulties, have not, with any certainty, convinced us that spontaneous generation does take place, although his arguments and conclusions, founded on his practical investigations, help us to realise that its existence is not a myth. To hold a biassed opinion on this question, Rücker has well said, is "to beg the whole question at issue; to decide the cause before it has been heard." Pasteur was convinced of the impossibility of "life existing without an anterior and similar life," having failed to find proof of it after twenty years' labour. Dr. Bastian is equally positive that Heterogenesis is a reality. Thirty years ago he turned his thoughts to the doctrine of Heterogenesis; the evidence brought forward in its favour, is that of a mature observer, working in Nature's laboratories in quest of her secrets. The conclusions drawn harmonise with the accumulation of evidence arising from observation and experiment, and all that is expected is that they be the subject of impartial consideration. The views advanced do not postulate any inexplicable departure from the uniformity of Nature. Before us is a volume which will make thinkers ponder the more, and should stimulate scientists to fresh endeavour to emulate the author in attempting to solve the problem of the nature and origin of living matter.—S. G. M.

The Bontoc Igorot, by Albert Ernest Jenks. Department of the Interior U.S. Ethnological Survey Publications; Vol. I. The United States Government is preparing to consolidate its dominion over the Philippine Islands by a scientific survey, not alone of the physiographic aspects of the new territories, but of the anthropological attributes of the peoples who are to be governed. It is an example which may be commended to the notice of the British Government, and the first of the publications of the new survey is in many respects a model publication. The Bontoc Igorots, who are a tribe living in the interior of the northern island of Luzon, were selected for examination; and Mr. Jenks, the Chief of the Ethnological Survey, accompanied by his wife, spent some six or seven months among these primitive people, photographing, measuring, observing; and learning their language. The results are embodied in the work before us, a heavy volume—though heavy only in the physical sense—well illustrated by between one and two hundred photographs, diagrams, figures, and plans. The Bontoc Igorots are a simple race, industrious agriculturists, with hardly any vices, no pastimes to speak of beyond the stimulating sport of head hunting, and remarkably few beliefs or prejudices. They are good natured, kindly and generous; and they are, one would say, a race well fitted to live long. They are of good physical development, neither tall nor short, fat nor emaciated, and suffering from no organic diseases. Yet—such are some of the paradoxes of the simple life!—they grow old at forty-five, they are quite old at fifty-five, and hardly ever live to seventy. The only reason which in this bulky and interesting monograph we have been able to discover for their failure to live to a hundred, is in the recipe for one of their beverages. It is called "sa-fu-eng," and is prepared as follows: "Cold water is first put in a jar and into it are thrown cooked rice, cooked camotes, cooked locusts, and all sorts of cooked flesh and bones. The resulting liquor is drunk at the end of ten days." Mr. Jenks says that it smells worse than anything else in Bontoc; and he is puzzled to account for the absence of fatal consequences. To our minds it shows only what fine constitutions these primitive people possess; though the fact of the shortness of their days is still unaccounted for.

Of **Jack's Scientific Series** (T. C. & E. C. Jack; price 1s. each) we have received five new volumes. **Meteorology**, by J. G. McPherson, Ph.D., F.R.S.E., is a handy little book, containing a number of interesting facts in all branches of meteorology. But the composition is not as satisfactory as it might be. There seems to be a strained attempt to make the language simple and childlike, and yet much of it is far from being clear, even to the intelligent reader. For instance, what is meant (on p. 92) by "The leading winds are under the calculation of the meteorologist, but the others will not be bound by laws"? It seems rather superfluous to tell us "The soft rain on a genial evening or the heavy thunderstorms on a broiling day are too well known to be written about" (though such subjects would seem to be the object of the book), and "Sometimes rain is earnestly wished for, at other times it is dreaded, according to the season."

Sociology, by C. W. Saleeby, M.D., is another of the series. Whether "Sociology" can be called a science, and divided into "pure Sociology" and "applied Sociology" is a matter that we need not here discuss, but the author himself does not lay stress on this point, and merely goes ahead to relate in comprehensible language some of the leading facts which are to be included under this head. Part I. consists of a general survey of society, sexes, and social organism, together with the origin and future of Religious Belief. Part II. deals with such subjects as Education, Society and Crime, Socialism and Politics. Two more books of the series are by the same author, Dr. Saleeby, and on very kindred subjects. **Heredity** discusses modes of reproduction, facts and laws of Variation, Mendelism, and Inheritance. **Organic Evolution** treats of the Evolution of Life, Natural Selection, and one chapter—which will doubtless be generally sought for—on the Future Evolution of Man. Here, the author tells us, we may look for improvement. Not only is the intelligent and the conscientious man more likely to gain the admiration of a fellow-woman, but, what is nowadays more practically important, such an individual is more likely to gain a post, giving him the means to marry. **Psychology** is yet another volume by Dr. Saleeby, and this treats of the Evolution of Mind and Will, Association of Ideas and of Sensations, and ends up with a chapter on Psychical Research.

The Voyage of the "Discovery," by Capt. R. F. Scott, C.V.O., R.N., 2 vols. (Smith, Elder, and Co.; price 42s. net).—A book of this nature, a record of three years of travel, and a record which must bear the stamp of an official report, cannot but be bulky, and there is more than this to be included. A general history of Antarctic navigation is a fitting introduction to the story, and then a full account of the inception of and preparations for this particular expedition must necessarily follow. Once started on the voyage all is plain sailing, and from Christmas Day, 1901, till September, 1904, an almost daily account of life and adventure in the Antarctic is presented. It will not be necessary here to repeat any of the tale which is told. The book is written in a style that needs no translation, clear, and without technicalities, and the detail of life in those dreary wastes and inhospitable climes is rendered full of interest. Moreover, much of it is exciting reading. Some of the thrilling adventures met with are graphically described, and the accounts of fierce gales howling around the ship fast in the ice, snow drifting deeply and almost burying the whole vessel beneath it, the windmill wrecked and chimneys damaged, but all the while the crew joining in a humorous discussion on "Women's Rights," are truly exciting and diverting. The naturalist, the geologist, and the meteorologist will find much matter of interest. What with penguins and very many other birds, to say nothing of whales and seals, there is plenty of life to describe, while two Appendices treat of the geological observations, the zoology being contributed respectively by Mr. Ferrar and Dr. Wilson. The numerous illustrations, mostly from photographs, are excellent, and charts of the track complete this very readable and valuable work.

Smithsonian Institution Annual Report (Washington: Government Printing Office).—This report, besides containing the official and financial statements of the Institute, is full of interesting communications on various subjects. These include an account of experiments with the Langley Aërodrome; A paper by Professor Poynting on "Radiation in the Solar System"; a suggestive paper by Sir William Ramsay on the "Present Problems of Inorganic Chemistry"; one on the "Pearl Fisheries of Ceylon," by Professor W. A. Herdman; and many on "Archæology" (chiefly American). It is altogether a fascinating volume, attractive to almost every type of reader.

Guide to Finger-Print Identification, by Henry Faulds (Hanley: Wood, Mitchell, and Co., price 5s.). Now that finger-print identification is coming so much to the fore in criminal proceedings, public interest in the subject is naturally great, and this small book provides methods of identification. The author goes to some pains to explain that it is a popular fallacy to connect this subject with the name of M. Bertillon, whose system is wholly anthropometric. He, moreover, has failed to find corroboration of the oft-repeated statement that finger prints have been used for identification in China and elsewhere. But there seems almost too much space devoted to a collection of evidence to try to prove that the author was the first to introduce the subject. Like most others, this subject has only gradually come forward, and many, but especially including Mr. F. Galton, have had a hand in giving it the publicity it now enjoys. As a guide to the practice this book is decidedly disappointing, though it contains a number of useful facts scattered among its pages, and is clearly illustrated, mostly from enlarged photographs.

Nature through the Microscope and Camera, by Richard Kerr, F.G.S., F.R.A.S. (London: Religious Tract Society, 1905).—The number of people who find keen enjoyment in the study of the beautiful in nature is far greater than many would suppose. And though such students care little for the things that concern the systematist, they incidentally render him yeoman service. This is especially true of those who pursue the study of the infinitely little in nature, for to them we owe some of the most valuable advances in the evolution of the microscope. This really handsome volume is written especially for these who regard nature as a sort of Aladdin's cave to be exploited through the microscope. The richness of the spoils to be gathered in such hunting are not easily described, but some idea thereof may be gathered by a glance through the many beautiful illustrations which adorn the pages of this work. The store of good things which this cave of living wonders contains is limitless. Diatoms, and molluscan teeth, caterpillars' eggs, beetles' legs, the stems of plants, and the human skeleton are all shown to contain hidden and unsuspected beauty. Dr. Sims Woodhead has written an admirable introduction to this book, and Mr. Arthur E. Smith has contributed a really valuable chapter on "Practical Hints on Photo-Micrography."

Second Stage Inorganic Chemistry (Theoretical), by G. H. Bailey, D.Sc. (Lond.), Ph.D. Edited by W. Briggs, LL.D., M.A., B.Sc.; pp. 8 and 542; 3rd Edition (London: W. B. Clive; price, 4s. 6d.). Although this book is primarily intended to cover the ground included in the syllabus issued by the Board of Education it is yet more than a mere "cram" book and can be studied with interest by those who have not the fear of examination ever before them. It has been brought thoroughly up to date, and gives, for instance, a clear summary of recent discoveries about radium emanations and the "contact" method of manufacturing sulphuric acid. The text is illustrated by diagrams and figures of apparatus; experimental work is described wherever possible; and each chapter has a series of questions which will be found of the greatest use.

Future Forest Trees, by A. Harold Unwin, Assistant Conservator of Forests, Southern Nigeria (T. Fisher Unwin; pp. 108, three full-page illustrations; price 7s. 6d. net).—This book is likely to be of great utility, in view of the increased interest which is being taken in the question of re-afforestation in our own country. At the end of the 18th century Germany foresaw the importance of introducing certain American trees into that country, about 300 species being chosen. Some of these have become established, and this book gives an interesting account of the experiments tried by the German Government, and also of their failures, and the cause to which failure was due. The question of tree-planting is likely to be an important one in our own country, in view of the rapid disappearance of our forests and woodlands, and the very small amount of re-afforestation which takes place. Here there is good work to be done. In the ranks of the unemployed the necessary labour can be found. The institution of "Arbor-Day" is a step in the right direction, but whatever is done in the future, it will prove of great value to have a guide as to what trees will, and what trees will not, be suitable by way of increasing our own tree-flora, and in this useful work there will be fonnd a guide, from experience, or what experiments are likely to lead to failure, and what to success.

The Central Tian-Shan Mountains, by Dr. Gottfried Merzbacher. Published under the authority of the Royal Geographical Society (John Murray, pp. 285; 20 illustrations and folding maps; price 12s. net).—This magnificently-produced volume deals in detail with extensive exploration of the Tian-Shan Range in the years 1902 and 1903. It does not profess to be an exhaustive account either of the range or of Dr. Merzbacher's explorations, but it is sufficient to give an idea of the magnificence of the heights which he scaled, and the grandness of the glaciers which he crossed or viewed. The illustrations are as a rule full page, and are from very fine photographs. From the point of view of the mountain-climber, the book is of intense interest.

Elements of Mineralogy, by Frank Rutley, F.G.S.; 14th edition, revised and corrected. (London: Thomas Murby and Co.; pp. 251, illustrated.)—We welcome this edition of a well-known manual, packed full with material valuable to the mineralogical student. Particularly to be noted are five pages of very clear diagrams illustrating the various systems of crystallography, and the additional chapter on "Radio-Active Elements," by Ernest Howard Adye.

The Fungus Flora of Yorkshire, by G. Massee, F.L.S., and C. Crossland, F.L.S. (London: A. Brown and Sons, Farringdon Avenue; pp. 396.)—This book is an admirable summary of work done during many years by members and friends of the Yorkshire Naturalists' Union. It is modestly claimed that the work is but a "contribution" to the subject of the fungus flora of Yorkshire. That may be so, but it should serve as an example to other less active local natural history societies.

The Preparation of Manuscripts for the Printer. By Frank H. Vizetelly. (Funk & Wagnall's Company; price 3s.)—Should be a useful book, but as it is written for American readers there is much that is not applicable in English practice, and is therefore apt to confuse instead of enlighten. There are, however, many hints and directions which are universally applicable.

Introductory Mathematics. By R. B. Morgan. (Blackie & Son, Limited; price 2s.)—"This little book is an attempt to include in one cover all the Algebra, Geometry, and Graphs a boy ought to know before he can really be said to have done more than obtain an introduction to Mathematics." Such is the estimate of mathematical knowledge formulated in the preface. It would be more correct to say that a boy must grow up, and go to a university, and take a degree in mathematical honours before he can be said to have done so much as obtain an introduction to mathematics—unless that boy happened to be "made in Germany," when he would be initiated into what mathematics means a good deal earlier. But apart from the question as to what mathematics really is, the book appears to be a useful one. It consists mainly of easy exercises in the rules of algebra, slotting on squared paper and ruler and compass work. It thus embodies recent methods of teaching in a book of somewhat more elementary character than the majority. A few things might be improved, thus, after giving a rule for the area of a right-angled triangle, the author gives exercises in which the areas of figures made up of right-angled triangles are found, not by the rule but by the rough and ready method of counting squares. But in his examples the rule does not appear to be applied correctly, several broken squares being omitted that ought to be counted, and many counted that ought to be omitted. The results are not necessarily correct to the degree of approximation postulated in requiring boys to waste time in sharpening hard pencils to chisel-points. This last requirement (for which the author is in no way responsible) is calculated to lead to mischievous results later on, when boys ought to learn that the best drawn figure is only approximate, and that verifications by geometrical construction are not the same as proofs. But it must be claimed that the book puts a boy in the right way of getting a knowledge of what a great many people call mathematics, and what it is important for everybody to know.

Wellcome's Photographic Exposure Record and Diary. (Burroughs Wellcome and Co., London; price 1s.)—To the many who know this note book and diary it is only necessary to say that the volume for this year retains all its well-known features, while it is brought quite up-to-date in such tables as those of plate speeds, and has an improvement or two that add to the convenience with which it can be used. To any who have not seen it, we may say that it is a pocket diary of convenient dimensions and thin, one page to a week, with other blank pages for memoranda, and ruled pages for the record of as many negatives and prints as any photographer other than a trade worker or professional portraitist is likely to need, besides a great deal of letterpress information and an ingenious exposure calculator. The general information of the ordinary kind is compactly arranged, and the special information gives such details as photographers are most likely to need, including a system of judging the exposure necessary for making a negative under almost all conceivable conditions. The details of other photographic operations are given in terms of the firm's well-known "tabloid" preparations, but the directions are free from even the slightest evidence of a desire to advise the use of chemicals when they are not wanted. A photographer who needs elementary advice, or anyone who wants to develop and print away from home, may be assured that he will find sufficient information here.

Nature in Eastern Norfolk, by Arthur H. Patterson (London: Methuen and Co., 1905.)—Throughout the length and breadth of the land the haunts of our native birds are being steadily and swiftly encroached upon. Game preserving, drainage, and the builder have done, and are doing, a deadly work, and those of us who find delight in the wild-places of nature are left lamenting. Time was, when Norfolk was a veritable Avian Paradise. To-day, we turn sorrowfully to the remnant that is left us, wondering how long even these will succeed in holding their own. This being so, it is fortunate that in these evil times there should have arisen an observer like Mr. Patterson. With the zeal of the enthusiast he has gathered together a rich harvest of facts relating to the "good old days" from the lips of the grey-beards who passed their time amid these vanished and vanishing birds and their haunts. Of these old men some have passed the "harbour bar" already, while the survivors are being coaxed by the author into making him the repository for their remembrance of happier days. How much they have to tell that is worth knowing those who have read Mr. Patterson's earlier book, reviewed in these columns a few months since, will probably remember with pleasure. The volume which he has just given us may be regarded as a supplement to this. And it is in every way a worthy supplement. It is this, and something more; for it is packed with most valuable field-notes of their author's own making: shrewd observation, tersely expressed, on birds, beasts and fishes. It is altogether a charming book, tastefully bound, and well illustrated.

W. P. P.

Eggs of British Birds, by W. J. Gordon. (London: Simpkin, Marshall and Co.)—It is impossible to say anything favourable of this book. The coloured plates are crude; the writing is slipshod, while the list of "British Birds, Past and Present," seems designed rather to fill up space than to serve any useful purpose. But worse than all, purchasers will find that "particulars as to the measurement, colour, and occurrence of the eggs" will be found in another book!!! W. P. P.

More Natural History Essays, by Graham Renshaw, M.B., F.Z.S. (London: Sherratt and Hughes, 1905.) The author presents us in this volume with a series of extremely interesting essays on some of the more remarkable mammalian types. Herein will be found much valuable information culled from old and long-forgotten records, as well as a few things that are new, at any rate, to the non-professional zoologist. Mr. Renshaw writes with an easy grace that lends an additional charm to all that he has to say. Tastefully bound, and well illustrated, this is a book that should find many friends. We note some omissions, however, the most important, perhaps, being the absence of all reference to Mr. F. A. Lucas's valuable summary on the extinction of Steller's Sea Cow (*Rhytina Stelleri*); as well as the investigations of Dr. Stejneger on the same subject. W. P. P.

A Glossary of Botanic Terms, with their Derivation and Accent, by B. D. Jackson. (Revised edition, 7s.6d. net, 8vo. pp. 371; Duckworth and Co.)—In the first edition of the work under consideration, the author commences with a quotation from Dr. Johnson, "Every other author may aspire to praise, the lexicographer can only hope to escape reproach." The early demand for a second edition should convince the author that he has escaped reproach; in addition, it may be stated that he merits praise for the production of a book of reference indispensable to everyone interested in the study of botany from any standpoint. In compiling a Glossary, discrimination cannot be exercised to the same extent as in other cases, hence out of the 16,000 terms defined in the second edition, the same organ is sometimes met with under different names. This condition of things is to a great extent the outcome of personal vanity or self-assurance. An author dealing with a structure already indicated by a recognized term, too frequently considers it necessary to coin a new one, often for reasons only apparent to himself. Nevertheless, such new terms must be duly chronicled in a Glossary. Oecology, or the study of plant life in relation to environment, a somewhat new phase of botanical investigation, has necessitated a considerable number of new terms which are here for the first time included in a Glossary of botanical terms. The author, however, felt compelled to draw the line at such compounds as "Carex-Sieversia-Polygonum-coryphium," in the vulgate "The Sedge-smartweed Alpine meadow formation." This is an American production; it might have been German. As most such compounds have been coined by one person, a reference to the work where they occur is given. There are no illustrations, hence the leaves consist of paper, and the book is light and pleasant to use. The type is excellent, and the key-words are not indented, but readily catch the eye.

Creatures of the Night, by A. W. Rees. (London: John Murray, pp. xix. + 448, illustrated; price 6s. net.)—If only the author had avoided the senseless and irritating habit of designating animals by such titles as "Vulp the Fox" and "Brock the Badger" (he might just as well say "Badger the Brock"!), he would have succeeded in producing a charming book. As it is, these names get on our nerves; but we may hope that they will not have the same effect on other readers. Mr. Rees is a keen observer of Nature and a thorough lover of animals; making little ado about sitting up half the night to watch a badger peer forth from its earth, or an otter steal out of its holt. To many of us such vigils would be deadly wearisome; and naturalists therefore owe a debt of gratitude to the author, for if we are to arrive at a thorough knowledge of the habits of animals, it is essential that the creatures should be thus carefully watched in their native haunts. British mammals of nocturnal habits form the main subject of the book, the otter, badger, fox, hare, hedgehog, and water and field voles (why does not the author call them by their proper country names—rats and mice?) forming the chief items; and in each case the life-history is charmingly written. Owls, nightjars, &c., are taken into consideration in the last chapter. In referring on page 441 to the object of the dark and light stripes on a badger's face, the author writes as though he were recording a new fact, which is not the case. The articles originally appeared in the *Standard*; but the re-publication in their present altered and expanded form is a distinct gain to natural history.

The Source of the Blue Nile, by A. J. Hayes. (London: Smith, Elder and Co., pp. xi. + 315.)—This work is in the main a record of the journey of a small expedition dispatched by the Egyptian Government to Lake Tsana, in Western Abyssinia, to which the author was attached as medical officer; the outward journey being by way of the Sudan, while the return route was to Egypt along the Atbara valley. Western Abyssinia is a country but little known to Europeans, and the author and his party traversed one district where white men had apparently never previously been seen. Western Abyssinia, as is pointed out in the preface, dominates the adjacent districts of the Sudan, and the importance to Great Britain of the continuance of good relations with the Ethiopian Empire is therefore self-evident. In addition to the narration of the journey, the book contains a number of observations on the religion, customs, &c., of the Abyssinians; and antiquarians should be much interested in a photograph of early paintings in the church at Bahardar Georgis. From the limited amount of available carriage, natural history collecting could be carried out only to a small extent, but Dr. Hayes was enabled to bring back a series of insects, which Professor Poulton describes in an appendix as being valuable and interesting from a distributional point of view. A few specimens of larger animals obtained by the author are shown in reproductions from photographs, among these being the "head of a hartebeest." This is a somewhat vague term, and the author might surely have found a naturalist friend to tell him that the specimen belongs to the tiang (*Damaliscus corrigum tiang*), an antelope which can only be called by courtesy a hartebeest, of which group it is a very aberrant representative. To all interested in adventurous travelling and the opening-up of Africa, Dr. Hayes's volume may be cordially commended.

Magnetism and Electricity for Students. H. E. Hadley. (Macmillan and Co., 6s.)—The scope of this volume is, roughly, that required to pass candidates for the B.Sc. examination of the University of London, and by students working for stages II. and III. of the Board of Education examination. The author has succeeded in compressing a very large amount of instructive information into its 575 pages; this information is conveyed wherever possible with the help of most excellent diagrams. There are a large variety of questions set at the end of each chapter which are selected, in the main, from examination papers. These will prove very useful, but their utility would be increased, especially to the private student, if answers were provided to more of them. The subject matter is, as a rule, very correctly presented. Some slips, such as fig. 51, ought to be rectified. This diagram gives an entirely misleading notion of the forces between an iron filing and a magnet. Diagram 54 on the following page indicates lines of force entering and leaving an iron ring (such as a Gramme-ring) much as though the flux was carried on by its own momentum. Teachers are exceedingly slow in learning that if the line reaches the iron surface even *slightly* inclined to the normal, then on the inside of the surface it is very nearly at right angles to its previous direction; that is, it is suddenly rotated through nearly a right angle. This action is a consequence of the high permeability of iron. In spite of these and certain other inaccuracies and deficiencies we can recommend the book as giving in general a simple and satisfactory account of its subject.

Circulating Scientific Library. Mr. H. K. Lewis, 136, Gower Street, W.C., has sent us a copy of Nos. 23 and 24 of his "Quarterly List" of additions to the circulating library. The lists contain nearly 300 titles, and include many important new books and new editions on the various subjects covered by the library. There are brief notes to most of the books which, while not pretending to give the subscriber an exact idea of the book, enable an opinion to be formed on its general scope. The library has been long known as a useful medium for the supply of medical literature, and its extension to cover all branches of general science, commenced some two or three years ago, should add considerably to its value. We understand this neatly printed and useful "Quarterly List" will be sent post free regularly to anyone desiring to have it, and should think it would prove of service to all our readers who desire to keep themselves abreast of the important additions to scientific literature.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Seasonal Changes on the Moon's Surface.

PROFESSOR W. H. PICKERING has several times suggested that he has obtained photographic evidence of real changes on the lunar surface, and he has recently stated that there will shortly occur a favourable opportunity for critical examination of one of these supposed variable features. This is in connection with the small crater Linné, and the special observations can only be properly made at the time of a lunar eclipse, so that this may be done on February 8 next.

While several observers have proved that the size of the white area surrounding Linné is dependent on the time that the sun has been shining on it, or, in other words, the co-longitude of the sun as seen from the moon, only four, Douglass, Saunder, Wirtz and Pickering have been able to observe it at the time of a total eclipse. The observers in question all agree that the white spot appears larger after emerging from the Earth's shadow than it did before it entered it. Hence it is very desirable that not only should the number of observations be increased, but definite measures of the extent of enlargement might be obtained if systematic arrangements are made.

The observation depending on the age of the moon may be made without great difficulty by comparing a pair of good lunar photographs, one taken soon after first quarter, the other near full moon, when the difference may amount to 2″ or 3″. In general the higher the sun the smaller is the spot. The observation during total eclipse is not so simple. An attempt was made during the last eclipse visible in America, in October, 1902, but failed owing to lack of co-operation. If observations can be secured this year, it is recommended that for an hour or so, both before and after the shadow transits Linné, as many micrometer measures as possible should be taken, all approximately in a north and south direction, as measures in this position angle are more accurate than others on account of the moon's orbital motion. Owing to the haziness of the edge of the white spot surrounding the crater, it would be advisable to start observations on a previous night to become familiarised with the region.

Rather conspicuous changes also occur in the white spots near the centre of Eratosthenes during the course of a lunation, and observers not possessing micrometers might endeavour to detect changes by comparison with neighbouring features of more constant dimensions.

Periodical Comets due in 1906.

Notice is given by Mr. W. T. Lynn of the expected return of two periodical comets during the present year.

Comet Holmes, which it is hoped we shall see during the spring months, was discovered at Islington on November 6, 1892, in Andromeda, and was first thought to be connected with the lost Biela's comet, but this was disproved when its motion was determined. It appeared strange that the comet was not seen about the time of its perihelion passage during August, 1892, and it has been supposed that a subsequent increase of intrinsic brightness may have taken place. The comet is remarkable for the small eccentricity of its orbit, which lies wholly between those of Mars and Jupiter; its *perihelion* distance from the sun is 2·2, and that of *aphelion* is 5·0. The period is about 6·8 years. It was seen on its second return by Professor Perrine on June 11, 1899, having passed perihelion on April 28. Another return to perihelion will therefore be due in the present year, and may possibly occur in the earlier months of the year.

Finlay's Comet, discovered at the Cape of Good Hope on September 26, 1886, passed perihelion on November 22 of the same year, and with a period of about 6½ years, was next seen in 1893 by Mr. Finlay again on May 17, which would be about a month before the calculated time of perihelion on June 16. At the return in the winter of 1899 the comet was unfavourably placed and escaped observation, and is due during the summer months of 1906.

Giacobini's Comet, 1905 (c).

This comet has been frequently seen on the Continent, but the unfavourable weather appears to have prevented many observations in England, as it could only be seen some little time before sunrise. Herr Strömgren has computed the following elementa:—

T = 1906 Jan. 22·63 G.M.T.
ω = 198 22′
Ω = 91 55′
ι = 43 37′
q = 0·2238

The following ephemeris will serve as a guide in searching for the comet:—

1906.		R.A.			Declination.				Comparative Brightness.
		H.	M.	S.		°	′		
Feb.	2	23	50	16	−	8	4	S	20
	6	0	33	34	−	1	40	S	14
	10	1	11	28	+	4	2	N	10
	14	1	42	48		8	48		7
	18	2	9	56		12	38		4
	22	2	32	56		15	40		3
	26	2	52	52	+	18	6	N	2

Recent Meteorological Determinations by Kites.

Although systematic examination of the upper atmosphere is not yet carried out on this side with the completeness adopted in America, where it is chiefly due to the initiative of Professor Rotch, of the Blue Hill Observatory, we have constant evidence of the tendency to recognise the importance of this somewhat difficult branch of meteorological science.

At a recent meeting of the Royal Meteorological Society, Mr. G. C. Simpson described a series of attempts to fly kites for registration purposes from the deck of a mission ship (*Queen Alexandra*) attached to a deep-sea fishing fleet in the North Sea. The work was carried out during July and August, 1905, on behalf of the joint Kite Committee of the Royal Meteorological Society and the British Association. Eight ascents were successfully secured, and the greatest elevation recorded was 5800 feet.

Mr. C. J. P. Cave gave an account of his operations in Barbados, during April and May, 1905, and from an examination of the traces secured, Mr. W. H. Dines concludes that the humidity there varied from 60 per cent. at the surface of the ground, rising to 80-90 per cent. at heights from 1000-2000 feet, and then gradually falling off again to 50 per cent. or less as the elevation still further increases. It is noted that these values are lower than would have been expected in the region over a tropical ocean.

The increase is of the normal type, but the maximum value occurs at a far lower elevation than is the case in Europe. Extended observations having shown that it is probable that the relative humidity forms a reliable guide to the state of the vertical circulation, a low humidity indicating a descending current of air, it may be inferred from the above observations that there is a settling down of the atmosphere over the regions of the smaller West Indian Islands during April and May.

We believe that experiments are also in progress by the Indian Meteorological Department for exploring the upper atmosphere by means of automatic instruments attached to kites, and if successful it is expected to derive much practical information which should be extremely useful in increasing the accuracy of the weather forecasts so necessary to the welfare of the industries of the country.

Intrinsic Intensity of the Solar Corona.

Observing at Burgos on August 30, 1905, M. Charles Fabry determined the intrinsic intensity of various portions of the coronal radiation during the Total Solar Eclipse. Using for comparison an Auer electric osmium lamp, the coronal image given by a lens of 1·20 metre focus was thrown on a plate carrying a diaphragm, so that any part of the corona could be examined at will and changes made quickly. The aperture of the objective could also be rapidly altered.

It was found that the intrinsic brightness of the corona at a point 5′ from the limb of the sun, in the direction of the equator, was about 720 candle power. That of the full moon was found to be 2600 of the same units, so that the intrinsic intensity of the coronal light at the point indicated was about 0·28 that of the lunar surface. This is in good accord with the previous determination by Turner in 1893, who, using a photographic method, obtained the value 0·25.

Comparing these values with the measured brightness of the sky close to the sun during ordinary times, it is found that the corona is probably about 2000 times less intense than the background of illuminated sky against which it is projected, and this indicates the difficulty to be contended with in any attempt to photograph or see the corona during ordinary sunlight. It is possible that certain exceptional stations at high altitudes, and with very dry climate, may offer the least discouraging conditions.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

A Method of Rendering Phosphorus Harmless.

A NEW process of treating ordinary yellow phosphorus has been patented by M. Bals in France. The phosphorus is mixed while in a melted condition, or as it condenses from the vapour in its manufacture, with a salt which does not decompose when melted, *e.g.*, sodium thiosulphate ("hypo"). The process must be carried out in a vacuum or in an atmosphere of inert gas such as carbon dioxide, so as to prevent contact with the air, and it is also recommended to use a liquid such as petroleum oil or turpentine in addition to the salt so as to coat each fine particle of treated phosphorus with a protective layer of substance that will prevent oxidation. It is claimed that finely divided phosphorus thus treated can be transported and used in the manufacture of matches without risk of injury to the workman.

The Toxine of Eel's Blood.

A characteristic kind of poison is found in the blood serum of the eel, conger, and certain allied species. It is formed as a normal product during the life of the fish, and in this respect resembles the venom of snakes, which has been shown to be present in the blood as well as in the poison glands. The eel toxine was discovered in 1889 by M. Mosso, who found that it prevented the blood of poisoned animals from coagulating, and since then its physiological properties have been thoroughly studied, notably by Drs. Camus and Gley, and more recently by Dr. Wendelstadt. The serum as obtained from the eel has a slight yellowish-green colour, and retains its toxic power for some time if protected from the light. There is a great variation in the degree of toxicity of the sera from different eels, the season of the year being a factor of considerable importance. The toxine itself has not yet been isolated in even an impure condition, although it has been shown that it has the same general characteristics as all true toxines as defined by Ehrlich ("KNOWLEDGE AND SCIENTIFIC NEWS," this vol., p. 317). Thus it is destroyed by heat and by strong chemical agents, and can be obtained in solid form without injury by evaporating the serum in a vacuum. It acts upon the respiratory centre, which it paralyses, upon the heart, and upon the nervous system, the general effects being very similar to those produced by snake venoms. It has also an active solvent effect upon the corpuscles of the blood. It is said to resemble snake venom in being harmless when swallowed, although Dr. Pennevaria records an instance of a man being poisoned after eating eel's blood. The probable explanation is that in that case there was some abrasion of the mucous membrane of the mouth or stomach, by means of which the toxine could gain access to the blood. Dogs are extremely sensitive to the action of the poison, whilst the hedgehog is almost completely refractory. As is the case with all true toxines, it is possible to produce an anti-toxine in the blood serum of susceptible animals, and thus to render them immune against enormous doses of the venom. Rabbits and goats are easily immunised, but it is very difficult to produce immunity in guinea-pigs.

The So-Called Gold-Coated Teeth in Sheep.

Mr. A. Liversidge has investigated the nature of the "gold" which has frequently been reported to have been found on the teeth of sheep. The teeth of the lower jaw bone of a sheep examined by him were encrusted with a yellow substance, resembling iron pyrites, the thickness of the deposit being less than $\frac{1}{32}$ of an inch. The incrustation was brittle, and could be removed in scales, leaving a black surface. When examined under the microscope the scales were seen to consist of thin translucent pale brown layers, but did not show any organic structure. They were partially soluble in dilute hydrochloric acid, and when heated turned black, leaving a residue consisting chiefly of calcium phosphate. The incrustation thus appears to be a deposit of tartar, accompanied possibly by slight decay of the surface of the tooth, and the metallic lustre is to be attributed to the reflection of light from the different surfaces of the films of the substance.

Natural Gas in Western Australia.

Prior to last year fire-damp was unknown in the mines of Western Australia, and it then appeared, not in a coal mine, but in a Kalgoorlie gold mine. In drilling a borehole there was, at a depth of 687 feet, a rush of gas which took fire on contact with a candle, and was not easily extinguished. The emission of gas continued for a month and then ceased, safety lamps being meanwhile used in the mine. Samples of this gas have been examined by Mr. E. Mann, the Government Analyst, and found to consist, in the main, of marsh gas (methane) and nitrogen, with from 5 to 8 per cent. of oxygen and less than 0·5 per cent. of carbon dioxide. It is suggested that there may be some connection between the occurrence of the gas and the presence of a band of graphite schist in the geological formation.

Radio-thorium: A New Element.

Sir William Ramsay has added yet another element to the long list of those already discovered by him. Radio-thorium, as this new element is termed, was isolated from the radio-active mineral, thorianite, from Ceylon ("KNOWLEDGE AND SCIENTIFIC NEWS," 1905, p. 228). It is very similar to the rare earth metals, and is distinguished from thorium by forming a soluble sulphate, and from radium by the solubility of its oxalate in ammonium oxalate solution. Its radio activity is 500,000 greater than that of thorium. Sir William concludes that the helium found in thorianite is derived from radio-thorium, and suggests the following scheme as illustrative of the relationship: Inactive thorium —> radio-thorium —> thorium X —> emanation —> thorium A —> thorium B —> ? —> helium.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Carboniferous Rocks at Rush.

LEAVING for the time being his researches into the geology of Anglesea, Dr. C. A. Matley has turned his attention to the "Carboniferous Rocks at Rush (co. Dublin)," and has laid the results gained before the Geological Society. Dr. A. Vaughan has in the same connection dealt with the "Faunal succession and correlation of the rocks," which extend for a distance of five miles along the coast near Rush. The southern portion of the tract consists of an exposure of about 2500 feet, the range being from the upper *Zaphrentis* to the upper *Dibunophyllum* zones. The Rush Slates are the lowest beds, and are 1380 feet thick, the characteristic fossil being *Zaphrentis* aff. *Phillipsi*. Above these is the Rush conglomerate group, 500 feet thick. In these conglomerates are found Osdovician and Silurian rock-fragments, together with many inclusions of carboniferous limestone. Above the conglomerates are some beds, mainly limestones and calcareous shales, which have been thrown into numerous sharp folds and are occasionally inverted. The highest beds seen were the *Cyathaxonia* beds, correlated with the Oystermouth Limestone of the South-West Province. Dr. Matley proposes to continue his investigations into the northern portion of this interesting series.

Rocks of the Ludlow District.

There are few women geologists of front rank, and for the matter of that, there are unfortunately but few women geologists at all. The times move on, however, in this respect as in other fields of labour, and, to their credit be it said, the Fellows of the Geological Society raised no objection to the presence of ladies at their meeting at Burlington House, when Miss Gertrude L. Elles, D.Sc., read a joint paper by Miss I. L. Slater and herself, on "The Highest Rocks of the Ludlow District." Unfortunately every new worker on any given set of rocks thinks it well nowadays either to adopt a new classification or to introduce new names to old rocks. Granted that this may be advisable, or even necessary, on occasion, but there should be great hesitation in doing so, except under sheer necessity, whilst even in such case experience shows that new classifications of rocks seldom become generally accepted. In the paper in question, the authoresses give the following classification :—

	Feet.	
III. TEMESIDE GROUP	110 to 120	Zone of *Lingula cornea* and *Eurypterus*.
	30 to 50	Zone of *Lingula minima*.
II. UPPER LUDLOW GROUP.	150 to 160	Zone of *Chonetes striatella*
	110 to 120	Zone of *Rhynchonella nucula*.
I. AYMESTRY GROUP.	40 to 150	Zone of *Dayia navicula*.
	75 to 250	Zone of *Conchidium Knighti*.
	515 to 850	

A mass of most interesting and technical information is given in the paper, and the remark is made that the main tectonic features of the district appear to be due to the superposition of Armorican movements in rocks with a Caledonian trend, held by some rigid mass to the north, presumably the Longmynd massif.

Water Supply.

The cry for new water supplies to satisfy our ever-increasing town populations is heard now in one direction and now in another. Near London there are so many draughts made upon the chalk both for private and public supplies, that the water-level is steadily diminishing, besides which there is the fact, not yet satisfactorily explained, that while one deep boring will yield a bountiful supply another a mile away results in disappointment. Croydon has been fortunate hitherto in sources of supplies at her very doors, but in order to allow for the necessities of a further increase of her present population of 150,000 persons, the local authorities are anticipating an expenditure during the next ten years of nearly a quarter of a million, in order to tap fresh sources of supply. To do this, it will be necessary at length to go outside the borough borders, special stress being paid in the selection of a site as to whether or no the chalk is covered by a sufficient depth of tertiaries to form a suitable filtering medium. It is a matter of opinion as to what quantity of the water obtained actually passes through the overlying deposits, and when those fertile fissures are struck, which water-borers eagerly anticipate, the probabilities are that a very small quantity of the water thus gained ever passes through the covering at all.

The Yorkshire Cliffs.

"The Making of East Yorkshire" is a chapter in local geography to which Mr. T. Sheppard, F.G.S., has given his attention, and his booklet on the subject which has reached us is an interesting and popular description of the Yorkshire cliffs, and the coast to Spurn Head, where there are no cliffs to speak of at all. Amongst other remarks, he gives us some idea of the loss of land by erosion by his estimate of the loss of 7 feet per annum throughout a length of 30 miles. Much of the denuded material is helping to extend Spurn Head in a south-westerly direction.

"Scree" below Snowdon.

Our illustration gives an idea of the scree formed by tumbling of Silurian blocks down the Capel Curig side of Snowdon. It is a subject for consideration when first the

"Scree" below Snowdon.

scree was formed, whether there is any movement in it now, and if so, at what rate the movement is proceeding.

[The Geological Editor would be glad if readers will bear in mind that he is always glad to receive geological and kindred notes for publication, and also copies of papers read before local societies. They can be sent to him, c/o KNOWLEDGE, or to his address at 58, Whitworth Road, South Norwood, S.E.]

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Kea Parrot and Sheep Slaughter.

WE have always felt that if there were any truth at all in the stories of the depredations caused by the Kea Parrot (*Nestor notabilis*) on New Zealand sheep farms, they must be greatly exaggerated.

In the Field (Dec. 30), "R. L." gives a brief account of the results of a conference of representative men held recently in Wellington. It would seem that they have been enabled to show that these stories are without foundation in fact. "All the members of this conference were men well acquainted with this bird in its native haunts, but not one of them, either as the result of his own experience, or from the testimony of others, was able to adduce a single item of evidence in support of the alleged sheep-worrying charge."

It is well that this exoneration comes now. For years these birds have suffered a grievous persecution, so much so that they are on the verge of extermination. Whether of the remnant that is left enough remain to restock the depleted areas time alone will show.

The Protection of Small Birds.

We are glad to note that the German Board of Agricultural Biology and Forestry has taken up the question of the protection of birds useful to agriculturists. Mr. Dunnington Jefferson, in the *Field* (Jan. 13), gives a short account of the efforts that are being made to this end, though we cannot but feel that some mistake has been made concerning his account of the endeavours which are being made by way of tempting insectivorous birds to breed. Not only have nesting-boxes been put up, but according to the authors nests have been supplied to save the birds the trouble of building. "The Department," he says, "has undertaken the supply of artificial nests suitable for the different species . . . for swallows, moss or a few dead leaves are provided"! Either the translator has misread some portion of the original account of this work, or the well-meaning authors of these nests have not so wide a knowledge of field ornithology as we should expect. Be this as it may, the provision of nest-boxes, and the efforts to encourage these birds, is a step in the right direction. In this country the question of the protection of birds is a cause of much difference of opinion; and we shall never arrive at any satisfactory solution of the problem until the matter is taken up by the Board of Agriculture as is done in Germany and America.

Lesser Grey Shrike at Chichester.

At the last meeting of the British Ornithologists' Club (Dec., 1905), Mr. A. F. Griffith exhibited a specimen, in autumn plumage, of the Lesser Grey Shrike (*Lanius minor*), which had been killed near Chichester in October, 1905.

Little Shearwater at Lydd.

At the meeting above referred to a male example of the little dusky Shearwater (*Puffinus assimilis*), which had been captured at Lydd, in Kent, was exhibited on behalf of Dr. N. F. Ticehurst. This bird, which marks the fourth occurrence of this species in Britain, was taken alive after the south-west gale of Nov. 26.

Breeding Place of Ross's Gull.

Mr. H. E. Dresser at this same meeting announced the fact that a breeding place of Ross's Gull (*Rhodostethia rossi*) had been recently found in the Kolyma delta, North-East Siberia. Mr. Buterlin, a Russian naturalist, the fortunate discoverer, procured an adult bird, young in down, and eggs.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Instrument for Compounding Vibrations.

THE following means of compounding several harmonic motions, all taking place parallel to one straight line, is described by Lord Rayleigh in the *Philosophical Magazine* for January.

"A wooden batten, say 1 inch square and 5 feet long, is so mounted horizontally as to be capable of movement only along its length. For this purpose it suffices to connect two points near the two ends, *each* by means of *two* thin metallic wires with four points symmetrically situated in the roof overhead. . . . The movement of the batten along its length is controlled by a piece of spring-steel against which the pointed extremity of the batten is held by rubber bands. Any force acting in the direction of the length of the batten produces a displacement proportional to the force. The tracing point by which the movements are recorded is at the other end, as nearly as possible in the line joining the two points of attachment of the four suspending wires. The longitudinal forces are due to the vibrations of pendulums hanging from horizontal cross pieces attached to the batten at their centres. The two ends of a wire or cord are attached to the extremities of a cross piece, the bob of the pendulum being a mass of lead (perhaps half a pound) at the middle of the cord. When set swinging the movements of the pendulums are thus parallel to the batten, and tend to displace it along its length." The smoked paper or glass upon which the style leaves a trace must, of course, be given in addition a uniform motion either by drawing it along a guide, or by rotating it in its own plane like the face plate of a lathe. If done in the latter way excellent lantern slides may afterwards be made by photography showing the resultant effect of combining simple harmonic motions in the way described. If it be required to make the component vibrations have periods in simple proportion to one another, it must be remembered that the period of a pendulum is proportional to the square root of its length (*i.e.*, in this case the distance of the centre of the bob to the centre of the line joining the ends of its suspending wires). For example, the effect of combining a note and its octave (which has half the period of the note) can be illustrated by having two pendulums only, whose lengths are, say, 4 feet and 1 foot.

Active Deposit from Radium.

Dr. H. L. Bronson shows (1) that temperatures between 700° and 1100° C. do not permanently affect the rate of decay of the active deposit from radium; (2) That radium B and not radium C has the longer decay period; (3) That the previous values of twenty-eight and twenty-one minutes are both too large for the decay periods of radium B and C respectively; and that twenty-six and nineteen minutes are much closer to the true values.

ZOOLOGICAL.

By R. LYDEKKER.

Regeneration in Mammals.

AT the December meeting of the Zoological Society was exhibited the skeleton of the tail of a dormouse showing distinct evidence of reparation after an accident; this being apparently the first recorded instance of the regeneration of bony structure in mammals. The re-formed vertebra, which had assumed the form of a slender rod, was composed externally of true bone, whereas in the regenerated tails of lizards the new structure consists of calcified fibro-cartilage.

Spicules of Sponges.

A remarkable instance of diversity of view is exemplified by two explanations which have recently been offered of the function of the triradiate mineral spicules found in many sponges. A writer in the November issue of the *American Naturalist* tells that these structures at first merely took the form of small spiny developments in the flesh in order to prevent sponges from being eaten by other creatures. As time went on these spicules were carried to the perfection of symmetrical development by what the author is pleased to call "momentum," that is to say, the continuance of development along a particular line long after any useful result accrues to the animal in which such evolution takes place. By a curious coincidence, in the *Quarterly Journal of Microscopical Science* for the very same month, an English naturalist points out that these triradiate spicules are probably a special adaptation to prevent the stems of slender sponges from being broken by the action of the waves of the shallow water in which they grow; the triradiate form affording protection in three different planes. The moral of this is, Never affirm a structure to be useless unless you are absolutely sure there is no possible purpose it can serve.

Fossil Flying-fishes.

Fossil flying-fishes form the subject of an interesting and well-illustrated communication by Dr. O. Abel to the Year-Book of the Austrian Geological Survey. At the present day there are two distinct types of flying-fishes, namely, the flying-gurnards and the flying-herrings, the latter being what may be called the typical flying-fishes; and it is quite evident that each of these has acquired its powers of flight quite independently of the other. Similarly, Dr. Abel shows that in past geological times several kinds of fishes, totally distinct from the modern types, possessed long pectoral fins, which were intended, in all probability, to enable their owners to skim the surface of the water in flying-fish fashion. The earlier of these fishes—*Thoracopterus* and *Gigantopterus*—occur in strata belonging to the period of the Trias, or New Red Sandstone, and, like their non-flying contemporaries, had their bodies encased in an armour of quadrangular enamel-covered scales.

Papers Read.

At the meeting of the Zoological Society held on December 12, Mr. H. R. Hogg read a paper on South African spiders of the family *Lycosidæ*; Mr. O. Thomas discussed mammals collected in Persia, describing a new genus and species of hamster-like rodent allied to the North America *Peromyscus*; colour-variation in a beetle formed the subject of a communication by Mr. L. Doncaster; the Society's Prosector discoursed on new worms; Dr. de Man described a crab and a prawn from Christmas Island; the heredity of webbed feet in pigeons was discussed by Mr. R. S. Browne; while Messrs. Warburton and Pearce gave an account of new and rare British *Oribatidæ*.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 336.)

THE axis of the microscope should point straight down the camera baseboard towards the light, parallel with the sides; it must be truly horizontal and the disc of light should appear exactly in the centre of the ground-glass screen. Now remove the objective and the ground-glass screen and look straight along the tube, and then adjust the illuminant until it appears in the centre of the limited field of view. Next move the camera up in its slides until there is room for the head to be placed between it and the microscope in order to enable the eye to look down the tube. It is a convenience in this respect if the whole portion of the camera base which carries the microscope, lamp, &c., rotates on a pivot to one side.

We have now got the microscope in the place it will occupy in photographing, and we have also got the source of illumination approximately centred, but have still to centre the sub-stage and auxiliary condensers. First centre the sub-stage condenser. This is done in the usual way by using an ordinary eye-piece and a fairly low-power objective, say one inch, closing the iris-diaphragm as much as possible, and racking the body-tube up or the condenser down until the edges of the diaphragm appear in the field, so that the small central disc of light can be centred with the centring screws. Then focus the objective upon some suitable slide placed upon the stage and focus the condenser. If the image of the illuminant does not appear in the centre of the field it must be brought there by moving the illuminant laterally and not the condenser. This is sometimes rather a troublesome job as very small adjustments are required, and the hands cannot reach the light whilst the eye is at the microscope tube, so that assistance from a second person is of service. The auxiliary condenser now alone remains to be centred, and this can only be done by means of a cap of brass or blackened cardboard fitting on its anterior face, and perforated with a very small hole. This small hole is focussed by means of the sub-stage condenser, but it is brought central by moving the auxiliary condenser vertically or horizontally, and again not by re-centring the sub-stage condenser. Care must be taken that the auxiliary condenser is set true and square with the long optic axis, to which we have so carefully adjusted everything. It must then be decided at what distance from the lamp the auxiliary condenser shall be placed, whether to give parallel or convergent light, and if the latter, where the light shall come to a focus. The experiments with the white paper will prove very useful here. The blackened disc is, of course, removed after the centring, just as the iris-diaphragm of the sub-stage condenser is re-opened. On examining the ground glass screen, a bright and uniformly illuminated disc should be observed in the centre of the screen. Of course, with a one-inch objective the sub-stage condenser will probably not give a big enough field of light, in this case the top lens can be removed.

(To be continued.)

Royal Microscopical Society.

December 20, at 20, Hanover Square, Dr. Dukinfield H. Scott, F.R.S., president, in the chair. The President called attention to a donation of slides prepared by Andrew Pritchard, about 50 years ago, presented to the Society by Mr. N. D. F. Pearce, which were exhibited under microscopes in the room. Mr. Rheinberg called attention to an exhibit consisting of about 20 photographs of diatoms, taken by the Zeiss apparatus designed by Dr. August Kohler, of Jena, for photo-micrography with ultra-violet light, having a wave-length of 275 $\mu\mu$ (see "KNOWLEDGE" for June, 1905, p. 138). The photographs were taken with a 1.7 m.m. monochromatic objective of 1.25 N.A., using light from the cadmium spark, and having a resolving power equivalent to a N.A. of 2.5, with an objective used with ordinary light, were such possible. There were photographs of *Surirella gemma*, and *Amphipleura pellucida*, one of the latter, taken with oblique illumination, showing the diatom clearly resolved into dots. Photographs of the same diatom taken with a 2 m.m. apochromatic objective of 1.4 N.A., and light from the magnesium spark ($\lambda = 383$ $\mu\mu$), and at the same magnification, *i.e.*, 1800 diameters, were shown for comparision, and the difference was very apparent. Mr. Curties said that this was not the first time *A. pellucida* had been resolved into dots, for he remembered such a photograph being made by Mr. Gifford, whilst Dr. Spitta showed the diatom itself at one of the Society's meetings, but the resolution in these cases was less distinct than in the photographs now shown by Mr. Rheinberg. Mr. D. M. S. Watson read a paper on "A Fern fructification from the lower coal measures of Shore, Lancashire," and exhibited a large section of the coal under the microscope, also lantern slides to illustrate the paper. In the ensuing discussion, the President, Professor F. W. Oliver, and Mr. E. A. Newell Arber, took part.

Quekett Microscopical Club.

The 426th ordinary meeting was held at 20, Hanover Square, W., on December 15, the President, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., in the chair.

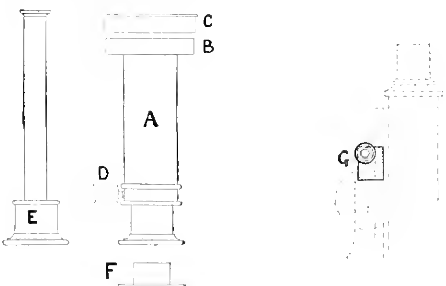
Mr. Bryce read a description by Mr. J. Murray, of a new Bdelloid Rotifer, from Upper Sheringham, Norfolk, under the name of *Callidina vesicularis*. It somewhat resembles the well-known *C. quadricornifera*.

The President then delivered a paper on "Some Experiments relating to the Insect Compound Eye." After some preliminary remarks, he reminded his hearers of the general formation of the human eye, laying especial stress on the extremely delicate nature of the retina. Considering the insect compound eye, he said one of the chief differences to be noted was that, in the human eye the retina was separated from the cornea by a lens (not to mention two fluid media), while in the insect, the retina was in actual contact with the back of the cornea. He suggested that there was no real lens at all in the eye of most insects, and quoted the last edition of Dr. Packard's "Entomology" in support of his statement. He believed that the cornea might be considered as a series of small holes. The lecturer then reminded his audience how the multiple images of the so-called insect-eye were obtained in the microscope, and attention was drawn to the fact that, to make the experiment, only the cornea of the eye is used by the microscopist—the soft parts being usually washed away, or otherwise destroyed in the mounting. After referring to several of the difficulties met with by those who accepted the orthodox theory on the subject, the President said that, in his opinion, all these difficulties, anatomical, physiological, and physical, might be swept away by regarding each facet as a little hole (possibly filled with a simple non-refracting material). After dealing with various points connected with this suggestion, the lecturer went on to describe an experiment he had made which seemed to support his contention very strongly. A photograph of a piece of perforated zinc was made, so very much reduced as to almost require a lens to see the holes. This little artificial cornea was then placed on a microscope stage and a very small cross marked on the mirror below. A slide then thrown on the screen at once displayed the multiple image effect produced by these artificial means.

A very interesting discussion followed the lecture.

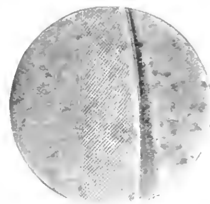
Gordon's Apparatus for Photo-micrography.

Many microscopists must have often desired some simple form of photo-micrographic camera which could be readily applied to a microscope, with little re-adjustment, to obtain a photograph of some object which is being examined visually. Mr. J. W. Gordon has designed a small camera for this purpose, which, whilst not differing in principle from other cameras of the sort, such as that made by Mr. John Browning, contains several original and useful features. Briefly, the camera consists of a circular brass tube (A) about



six inches long, which is placed over the microscope eyepiece. At the upper end of the tube a small cap (B C) contains a photographic plate, in size one quarter of an ordinary lantern plate, *i.e.*, $1\frac{5}{8}$-inch square, giving circular pictures $1\frac{3}{8}$-inch in diameter. Between this and the eyepiece is a projection lens focussed upon the plate, and there is also a small exposing shutter (D). Such a camera can be kept close at hand during one's work, ready for use at any time. If the observer's sight is normal, the photograph will be sharp when the microscope is focussed for ordinary vision, but as most people have some slight abnormalities of vision, a duplicate tube (E), with a high-power focussing eyepiece, is supplied. This is first placed on the microscope, in order to focus, and then merely replaced by the camera. A small flange (F), fitted over the upper end of the microscope, forms a table upon which to rest the camera. It has been found that microscopes used in an upright position for photo-micrography, have a tendency to move slightly downwards, and to prevent this a small metal block (G) is provided, which fits above the coarse adjustment and clamps the tube in any position. The principle of this clamp is so simple that one wonders it has not been thought of before. It can be made to fit any microscope, and should be equally useful in preventing broken slides at microscopical exhibitions. The whole apparatus is noticeable for its extreme simplicity, ease of adjustment, and moderate price, whilst the two photographs reproduced herewith will show what

Tongue of Blowfly.



Pleurosigma Formosum.

the resulting photographs are like. I may add that these photographs were taken with a Welsbach gas lamp, and a yellow screen, with exposures varying from 20 to 60 seconds. The apparatus is made by Messrs. R. and J. Beck, Ltd.

Microscopic Slides.

Messrs. Clarke and Page, of 104-106, Leadenhall Street, E.C., have sent me four very beautiful slides of marine objects. The staining and mounting show the structures to unusual advantage, and the prices are moderate. Messrs. Clarke and Page bought the stock of Mr. Jas. Hornell, which was, of course, limited, and I understand that these slides are their own mounting to replace his stock. They have sent me, at the same time, a catalogue of mounted slides, and if those I have seen are representative, they have fully maintained the high standard set by Mr. Hornell.

Notes and Queries.

W. Birrell, Kilmarnock.—All slides mounted for examination by transmitted light, that is, all transparent slides, can be readily shown upon a screen by means of a projection microscope, and they will, of course, thus retain their proper colours. But, unfortunately, such a microscope is rather an expensive apparatus, as the ordinary microscope is not suitable. A lantern is needed with a powerful source of illumination; nothing weaker than the oxy-hydrogen light is any good, and at a distance of more than a very few yards from the screen the arc light becomes necessary. Even with this last powerful light the difficulties become serious with the higher magnifications given by immersion lenses, but the oxy-hydrogen light is quite satisfactory for moderate distances and moderate powers. Then special parallelisers and condensers are necessary to supplement the condenser of the lantern. The microscope itself does not differ materially in principle from an ordinary microscope except that its body-tube is necessarily very short. I am afraid, therefore, your most economical method would be to make lantern slides of the objects you wish to show. You could, however, of course content yourself with borrowing as many microscopes and lamps as possible, and showing the slides after the reading of your paper. This is commonly done at meetings. Hand-microscopes, which can be handed round, are far from satisfactory.

S. P. Mummery, London, and *E. J. Adderley, Hull.*—I regret that owing to pressure on my space answers to your queries must be held over for another month.

[Communications and Enquiries on M[illegible] should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.]

The Face of the Sky for February.

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

The Sun. On the 1st the Sun rises at 7.42 and sets at 4.46; on the 28th he rises at 6.51 and sets at 5.35.

Solar activity is well maintained, and on almost any day spots and prominences may be observed.

The position of the Sun's axis and equator is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.
Feb. 1	12° 0′ W	6° 7′
,, 11	15° 55′ W	6° 43′
,, 21	19° 17′ W	7° 5′
,, 28	21° 16′ W	7° 13′

There is a partial eclipse of the Sun on the 23rd, invisible in this country, but visible in the Antarctic and S. Australia.

The Moon:—

Date.	Phases.	H. M.
Feb. 1 ..	☽ First Quarter	0 31 p.m.
,, 9 ..	○ Full Moon	7 46 a.m.
,, 16 ..	☾ Last Quarter	4 23 a.m.
,, 23 ..	● New Moon	7 57 a m
,, 1 ..	Apogee	1 6 p.m.
,, 13 ..	Perigee	10 12 p m

There is a total eclipse of the Moon on the 9th, but it takes place in the early morning shortly before sunrise, and is only partly visible in this country, the Moon setting totally eclipsed. The particulars are as follows:—

		h. m.
First Contact with Shadow,	Feb. 9,	5.57 a.m.
Beginning of Totality,	,, ,,	6.58 ,,
End of Totality,	,, ,,	8.36 ,,
Moon Sets,	,, ,,	7.30 ,,

Magnitude of eclipse (Moon's diameter = 1) 1·632.

Occultations:—

Date.	Star's Name.	Mag.	Disappearance. Mean Time.	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N point.	Moon's Age
			p.m.		p.m.		d. h.
Feb. 3	**Aldebaran** ..	1·1	5.23	40°	6.28	287	10 1
,, 4	115 Tauri	5·4	5.25	103°	6.33	232	11 1
,, 4	120 Tauri	5·3	9.54	18	10.26	331°	11 5
,, 7	ξ Cancri	4·7	7.7	60	8.4	308	14 2
,, 10	χ Leonis	4·7	11.7	134	a.m. 12.12	269°	17 6
,, 28	μ Ceti	4·4	7.0	54	p.m. 8.9	271	5 11

The Planets.—Mercury (Feb. 1, R.A. 20^h 4^m; Dec. S. 22° 3′. Feb. 28, R.A. 23^h 9^m; Dec. S. 6° 48′). The planet is in conjunction with the Sun on the 20th, and is practically unobservable throughout the month.

Venus (Feb. 1, R.A. 20^h 45^m; Dec. S. 19° 10′. Feb. 28, R.A. 22^h 57^m; Dec. S. 8° 13′) is in conjunction with the Sun on the 14th; towards the end of the month the planet is an evening star in Aquarius, but not well placed for observation.

Mars (Feb. 1, R.A. 23^h 51^m; Dec. S. 1° 31′. Feb. 28, R.A. 1^h 5^m; Dec. N. 6° 46′) may be observed, shining like a reddish star, in the evening sky looking S.W. The planet is situated in the constellation Pisces and sets about 9 p.m. throughout the month. On account of his small angular diameter he is not a very suitable object for observation in small telescopes.

Jupiter (Feb. 1, R.A. 3^h 38^m; Dec. N. 18° 42′; Feb. 28, R.A. 3^h 47^m; Dec. N. 19° 17′) is a very conspicuous object in the evening sky; near the middle of the month the planet is due south about 6 p.m., and is both well placed and easy of observation.

The equatorial diameter of the planet on the 13th is 40″·8, whilst the polar diameter is 2″·6 smaller.

The following table gives the satellite phenomena observable before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Feb				Feb				Feb			
1	I.	Oc. D.	8 47	9	I.	Sh. E.	11 23	18	II.	Oc. D.	8 23
2	I.	Tr. I.	5 57		II	Tr. I.	11 27		II.	Oc. R.	11 1
	I.	Sh. I.	7 15	10	I.	Ec. R.	8 40		II.	Ec. D.	11 4
	I.	Tr. E.	8 11	11	II.	Oc. R	8 25	20	II.	Sh. E.	8 43
	II.	Tr. I.	8 52		II.	Ec. D.	8 28	22	III.	Oc. D.	7 51
	I.	Sh. E.	9 28		II.	Ec. R.	11 1		III.	Oc. R.	10 0
	II.	Tr. E.	11 29	13	II.	Sh. E.	6 5	23	I.	Tr. I.	11 41
	II.	Sh. I.	11 20	15	III.	Ec. D.	9 22	24	I.	Oc. D.	9 1
3	I.	Ec. R.	6 44		III.	Ec. R.	11 13	25	I	Sh. I.	7 29
4	II.	Ec. R.	8 24	16	I.	Tr. I	9 45		I.	Tr. E.	8 24
	III.	Tr. I.	10 6		I	Sh. I.	11 5		I.	Sh. E.	9 43
8	III.	Ec. R.	7 11		I.	Tr. E.	11 59		II.	Oc. D.	11 0
	I.	Oc. D.	10 41	17	I	Oc. D.	7 4	26	I.	Ec. R	7 0
9	I.	Tr I.	7 51		I.	Ec R.	10 36	27	II.	Tr. E.	8 41
	I.	Sh. I.	9 10	18	I	Tr E	6 28		II.	Sh I	8 43
	I.	Tr. E.	10 4		I.	Sh. E	7 48		II.	Sh. E	11 21

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance, "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Feb. 1, R.A. 22^h 21^m; Dec. S. 11° 58′. Feb. 28, R.A. 22^h 33^m; Dec. S. 10° 47′) is in conjunction with the Sun on the 24th, and practically unobservable throughout the month.

Uranus (Feb. 2, R.A. 18^h 29^m; Dec. S. 23° 33′) is a morning star, rising about 5 a.m., near the middle of the month.

Neptune (Feb. 14, R.A. 6^h 34^m; Dec. N. 22° 16′) is due south at 8·58 p.m. on the 14th. The planet is situated in Gemini, but is difficult to identify among the numerous small stars in the same field, when viewed in a 3-inch telescope.

Meteor Showers:—

Date.	Radiant. R.A	Radiant. Dec.	Near to	Characteristics
Feb. 5–10 ..	75	+41°	η Aurigæ	Slow; bright.
,, 15 ..	236°	+11°	α Serpentis	Swift; streaks.
,, 20 ..	181	+34	Cor Caroli	Swift; bright.

Algol may be observed at minimum on the 7th at 9.36 p.m., 10th at 6.25 p.m., and 27th at 11.18 p.m.

Double Stars.—*Castor*, separation 5″·8, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

κ Geminorum, separation 6″·3, mags. 4, 8·5; very pretty double.

ξ Cancri, separation 1″·1, 5″·3, mags. 5·0, 5·7, 5·5; with small telescopes the wider component is readily seen.

ν Draconis, separation 61″·7, mags. 4·6, 4·6; a pretty and easy double, can be separated by observing with a pair of opera glasses.

SUPPLEMENT.

London's Transformation.

A Suggestive Sketch of Days to Come.

(*Continued from page 342.*)

By Tems Dyvirta.

[Cornelius Tush was a great American financier, whose modes of business were perhaps not always quite above suspicion. He had hit upon the great idea of diverting the course of the Thames so as to cause the river to flow away to the country, and leave its dry bed in London available for building sites. He had made business arrangements with a number of people, had formed a large Company to make the deviation, and finally the work was completed. Tush, however, was sorely disappointed with the treatment he had received in England, where many people looked askance at his methods, and had returned to America.]

CHAPTER XI.

America.

The United States were simmering, presently they would boil, but just now there were only indications of the coming excitement. For the time had arrived for the President to make his bow and hand over his grave responsibilities to another caretaker. A rich man can soon make himself popular, at all events, with the mob. A discreet man can always make himself looked up to; if he knows how. At this moment, too, the American people were suffering from one of their periodical attacks of Anglophobia. It is difficult to say exactly why. England had made herself objectionable in their eyes by successful negotiations which had ended in extensive annexations in the Far East. Though their Government had raised no formal objection, the citizens of the States felt they had been bested, and, nowadays, with their large and formidable fleet, which had been fostered and greatly increased during recent years, a warlike tone prevailed, which made them long for a chance of showing off their power.

Cornelius J. Tush, seeing his opportunity, soon became the man of the hour. A judicious and lavish expenditure of money, combined with his undoubted power of mind and the high repute in which he had formerly stood, soon brought him to the fore. There was another factor, too, that greatly added to his popularity. Libertia had now blossomed forth into a most beautiful and accomplished young woman, fascinating to all. She heartily entered into her father's interests, and though still young, had inherited so much sound shrewdness that she was able to be of the greatest assistance to him.

In due time the pot began to boil, and Tush was nominated as a candidate for the occupancy of the White House. Hatred of England now became the great election cry. This, of course, was thoroughly to Cornelius' heart. He hated the English intensely now that he had dug his vast fortune from under their feet. Unfortunately for him this feeling was not vehemently supported by his daughter; she had loved England. The few years she had spent there were some of her brightest (though they had such a melancholy termination), and she looked back on them with feelings of pleasure and admiration. English people had been so kind to her, and it had been of such absorbing interest to watch the great change developing in London with which she was so closely associated. She, poor girl, had known nothing then, and knew but little now of the awkward scandals associated with her father's name, and she often wondered at his speaking so bitterly of that country which had seemed to her a second home.

Not only had Tush succeeded in accumulating vast wealth in England, but some of his old speculations in the States had lately brought in considerable sums. Among them was the great ship canal which was now completed and open for traffic between the Atlantic and Pacific. This was at once recognised as a great strategical acquisition from a naval point of view. The United States influence in Mexico, too, had steadily grown, while that of England had for many years as steadily declined, and now it was actually suggested that that country should be incorporated in the States. To all this England had raised strong objections. The Hay-Pauncefort Treaty was continually quoted. The United States Government pointed out that England had, in Jamaica, a base of operations forming a dangerous obstacle to their use of the canal, that they were entitled to a similar base, and persevered in the negotiations. Relations became highly strained, and at this critical moment the presidential election took place. Everyone felt that the result of the election meant peace or war according as the republican, Mr. Sherston, or the democrat, Mr. Tush, were elected. Never before was there so much excitement over an election. Naturally the anxiety in England was almost as intense as that in the States.

In due time the election came about. Tush was returned as President by a large majority. The result was inevitable. New York was in a ferment, and every right-down Yankee clamoured for war. England was sullen and depressed. An ultimatum was sent, an unfavourable reply returned, and the sword was drawn.

"How sharper than a serpent's tooth it is to have a thankless child!" So might Britannia well have wailed. For a feeble old man to see his stalwart son in all his strength is a pleasure, but it is very humiliating if it comes to blows and the might of the offspring supervenes.

These were the sentiments of the British public when they heard the news that the entire fleet of the United States had set upon the few vessels we had in West Indian waters and beaten them completely. Pressing through the Ship Canal the American vessels had then gone in pursuit of our Pacific Squadron. The result could clearly be foreseen. Our ships were mostly scattered about and a long way from ports of refuge. To reinforce them would imply the withdrawal of our ships from nearer home. Australia, however, was threatened, and help must be sent. Finally it was decided to send off the whole of the Mediterranean Fleet to the East.

No sooner was the magnificent Fleet well away in the Indian Ocean than news arrived, scarcely unexpected, that most of our ships in the Pacific had succumbed to the superior force of the enemy. It was evident that our fleet must be pushed on with all speed, else Australia, or, at all events, her outlying islands, would be invaded.

Many anxious days passed awaiting developments. Meanwhile numbers of troops were being massed and embarked for Canada, and it was hoped that this would create a diversion necessitating the recall of the enemy's navy. It did so. One day the news arrived that their fleet had repassed through the Panama Canal and was once again in Atlantic waters. Yet most of our best vessels were on their way across the Pacific after them, and it was now ascertained that the United States, disregarding the neutrality of the territory, disdaining their former treaties, were erecting strong defences at the end of the Canal and were mounting such guns as would prevent our fleet from forcing its way through. And the position was in other ways very unsatisfactory. Most of our defence ships were convoying our troops to Canada, yet they would hardly be strong enough to resist the attack of the entire United States Navy. Many of the transports with their escorting men-of-war were captured in mid-Atlantic, and urgent messages had to be dispatched calling together all ships that could possibly be spared from other places to return immediately to the Channel for home defence. The Trans-Atlantic cables were cut, and direct communication with Canada ceased.

It was now evident that a very important naval engagement was about to take place, and, as practically all available ships of both sides were concentrated, it should have most decisive results. Both nationalities were confident of victory, and the movements of the two fleets, sent back by wireless telegraphy, were watched with the greatest of interest. Foreign nations, too, all stood by with bated breath as the two most powerful naval powers closed in the deadly embrace.

It was a calm, misty morning, the sea as smooth as a sheet of glass, but with a slight swell on, sufficient to cause a slow, lazy roll on the great leviathans awaiting their turn to enter the bloody arena. Suddenly the news flashed in from one of the reconnoitring destroyers that the hostile fleet was approaching. The British Fleet, responsive to the Admiral's signals, moved out to meet its foe. Scarcely had the first gun been fired from one of the advanced vessels than the *Queen Victoria* the finest ship in our Navy, was seen to heel over as a fountain of water flew up at her side, and rapidly she turned on her beam ends and sunk. Undoubtedly she had been struck by a torpedo, but whence did that come? Very shortly after another fine vessel went down in an exactly similar manner. The day was not favourable for gunnery, for the haze was so great that ships could not be seen at any distance. The British destroyers dashed boldly forth to launch their torpedoes, but they suffered heavily, for the enemy, awaiting their onslaught, could hear the approaching destroyer before she became visible, and were ready with their numerous guns to give the little vessel a terrible salvo directly she appeared in sight. A third of the big battleships having gone to the bottom in the same mysterious way, it was soon conjectured that the cause could be assigned only to submarines. Yet how could these be employed in mid-ocean? Soon the sharp look-out detected one emerging above the surface. It was soon seen to be of vast dimensions. Machine guns were at once trained to bear upon it, but the shots only spattered on the turtle-back harmless as rain. And now for the first time did the British officers realise that the Americans possessed a huge submarine battleship of the most powerful kind with armoured decks capable of turning aside even the heaviest projectiles. Another terrific report and a fourth splendid vessel became a total wreck. There was but one course to pursue, and that was to speedily fly from this infernal leviathan, and the British ships turned homeward, pursued by the undamaged enemy.

The game was up. The mighty British fleet, which had for so long ruled the waves, was beaten. The battered remnants put in to various ports around the coast, crest-fallen and vanquished. All that could be hoped now was that our ships from the far Pacific, hurrying on their homeward journey, and now already passing Malta, would be back in time to prevent any attempt at the invasion of England. But there came the awful news that several of the enemy's big ships had been sighted off Gibraltar, and that the door of the Mediterranean was carefully guarded. No single vessel dare approach the English coast for fear of encountering the powerful hostile fleet now patrolling around. Frantic efforts were being made meanwhile to prepare to resist any attempt at invasion. Food supply was the great question. So far most of the Continental routes were still open, guarded by the remnants of our navy. Vast stores were by this means being got into the country, though purchased at fabulous prices. Every available plot of land was being ploughed up to plant wheat. Cattle, imported by the thousand, were being killed off, and the meat preserved, so that the pastures could be turned into cornfields. The great fortifications already constructed around the North Downs were being supplemented by other works. The arsenals, as well as the dockyards, were as busy as they could be. Many of our best troops were either in Canada or had been captured en route. And what with our troubles in the Far East and a small frontier war in India having called away many more, we had but few regular troops left at home. Volunteers, however, came well to the fore, and were being rapidly armed, equipped, and drilled.

And meanwhile what was doing in America? The utmost enthusiasm prevailed. On the receipt of the news of the naval victory, citizens seemed to go quite mad with delight. President Tush, on leaving the Senate, received such an ovation as has seldom before been the lot of any man to receive. He was proclaimed Victor! Hero! Saviour of his country! His popularity and success were such that he had the whole nation in the palm of his hand and could do as he liked with it.

CHAPTER XII.

The Invasion.

One morning the good citizens of London were awakened to hear more alarming news. The American fleet had steamed up the Channel, driving before it such ships as remained to guard our shores. Following in the wake of this great squadron were a number of large transports full of troops. These, each having its appointed station, approached various points on the south coast and at once commenced to disembark its human freight. Urgent telegrams were sent hither and thither asking for troops and guns to be at once dispatched to this or that particular place. But when it became evident that there were some 12 distinct points of disembarkation, it was seen to be impossible to send to oppose each and all. To eight different districts had forces been sent, and these had arrived in time to offer good opposition to the landing; indeed, in several of these the invaders had received severe defeats and suffered heavy losses. But as more and more messages came to hand of forces landing all along the coast, it was evident that the actual invasion had commenced, and the enemy obtained a footing on our shores. When once complete units had been successfully landed in four different places, the troops from other points of attempted invasion were re-embarked and taken to these bases. The British Commander-in-Chief now decided on a plan of action. His forces being scattered and consisting mostly of untrained troops caused him to order a concentration on London, believing that to be the undoubted goal for which the enemy would make. The invaders could then knock their heads against our fortifications, while the army was properly organised for a great counter attack. On this account did the invaders receive but little opposition on their advance towards London, and within a few days they had formed up in positions opposite our southern line of forts. Englishmen were confident that their position would remain as it was until our forces were ready to assume the offensive, when the invading army would be driven back and the harbours on the south coast, now used as their bases of supply, re-taken. It was once thought that England could be starved out in a few days, but those who held such a belief proved to be greatly mistaken. Not only were enormous supplies imported when it became evident that they would be required, but now every man, woman, and child cheerfully complied with the edict to go on quarter rations, and contented themselves with the meagre portion doled out, under official supervision, to all alike. In this way the country was able to hold out four times as long as had been anticipated.

But a surprise was again awaiting the anxious Britishers. More Yankee notions were to prove their value. Dynamite guns and machine rifles wrought terrible havoc, but the most formidable innovation was the *Subterranean Torpedo*, capable of burrowing its way through the ground like a huge mechanical mole, and, at a given moment, raising a veritable volcano. Its progress underground was slow but very sure. The hydraulic drills which protruded from its head could bore into the hardest rock at a rate of 3 inches a minute, but this implied an advance of 120 yards a day. Within a week three of the principal forts had literally been blown into the air. The triumphant army then marched unhindered on London.

It was a frightful blow to England, but the opposite feeling in the States exceeded all bounds. Yesterday it was England's great first line of defence, the sea, that had yielded to the attack, and to-day her downfall was completed by the breaking down of her land defences.

Tumultuous exultation reigned everywhere. The President's last ovation could not be exceeded. Yet *something* must be done to celebrate this great occasion. The first vanquishing of a mighty power by the new nation, the conquest of an Empire of such huge proportions. America to rule the world! England's navy vanquished would leave that of the United States far superior to that of any other nation. Canada would, of course, be annexed to the States. Wild words are spoken on such occasions, and when it was suggested, half jokingly, that this mighty nation should be formed into an Empire, and the President chosen Emperor, the cry was vigorously taken up. Tush, wherever he went, was vociferously cheered and met with cries of "Emperor," "Founder of the Empire."

Those who may have gained some idea of Tush's real nature can imagine how things struck him. The first time he heard the suggestion his mind was made up. Why should he hang back when others pushed him forward? The result was—for he took good care to strike while the iron was hot—that within forty-eight hours the proclamation was issued that, by the unanimous consent of the citizens of the United States, Cornelius Jehoshaphat Tush was proclaimed Emperor of all the territories of North America!

The people of the States were in boisterous jubilation. But they were soon to receive a sad blow. This was not the first time in history when public rejoicings have proved to be a little premature. When the news came that the invading army had not yet actually entered London, it was considered merely a politic delay, and that the forts subdued and the way clear, the formal entry would very shortly take place. It now transpired, however, that one more obstacle had to be surmounted before that could happen—the New Thames. The northern bank of this great waterway was now found to form one continuous fortification. Tier over tier of rifle trenches had been constructed with loopholed steel armour facing the masonry. There thousands of rifles could belch forth their hail of bullets with practical impunity. For the American bullets and even shells struck harmlessly against these solid ramparts, except they happened on one of the very small openings through which the defenders' deadly missiles were emitted. But the actual parapets formed so small a target that very few projectiles struck them. The land torpedoes could be of no use here. The pneumatic guns threw their projectiles across, but they were unable to destroy the lines of narrow trenches in the far banks manned by thousands of British volunteers. After a heavy bombardment with all their guns, of many hours duration, the Americans were not able to advance in force across the water. Boats were procured, but soon sank under the tremendous rifle fire brought to bear upon them. The bridges were already destroyed, and all attempts to repair them under fire proved too costly to be continued. Attempts were made to ford the great stream in the shallow parts, but obstacles had been put in the way, making this impossible.

For two whole days the Yankees fought their hardest; hundreds of shells were sent into the far bank, but so well were the British entrenched that it was impossible to materially keep down their fire. Hundreds of the invaders were shot down in trying various methods of crossing, they being fully exposed to the British musketry fire. During the darkness of night boats full of men were pushed across, but it was found that there was a system of torpedoes laid near the far bank, and the only result was an appalling loss of life. Now for the first time did the public realise the reasons why the Government had insisted on the new river being made so wide. An endeavour was next made to outflank the position, but the far bank was found to be lined all along. Down stream the prospects of crossing over got more hopeless. Up stream the fight continued for many miles, but it soon became apparent that the passage of the big river, so well guarded, was a practical impossibility. For this dashing invasion, this raid in the enemy's country, no great store of supplies was available, and those already landed were nearly exhausted. The country through which they had marched had been cleared out of all food stuffs and supplies. For every available grain had been collected for the provisioning of the great city. About this time news filtered through that the great American submarine battleship had mysteriously disappeared, having, presumably, gone down with all hands. Now, too, the remnants of the British Navy had assembled together at the Nore and Sheerness, and received such refitting as was possible. At the same time came the news that the ships in the Mediterranean, issuing under cover of darkness, had suddenly attached and driven back the United States squadrons set to guard that approach, others having gone round the Cape and attacked them in the rear.

So the tide had indeed turned. The main portion of the American Fleet rapidly went south to endeavour to assist that part which was being worsted off the coast of Spain. The remainder had to meet the unexpected attack of the desperate squadron from the Thames. The results were everywhere fatal for the Americans.

The British Fleet chased and soon dispersed them near the Scilly Isles, and many being damaged and having no friendly harbour at hand to put in to, had to surrender, or else to try to make the great Atlantic trip in a disabled condition, in which but few were successful.

Meanwhile the invading army, running short of supplies and finding itself deserted by its ships, had no alternative but that of surrender.

Imagine the feelings of the newly made Emperor! The intelligence of one crushing blow after another came to his ears. The first had made him perfectly sick with rage. The next came as a thunder-clap which fairly broke him down. The great strain of the last few weeks, the excitement of the elections, the whirl of events on being elected President, the arduous duties which followed, especially on the outbreak of war, had been all too much for him. But there was something more in store for him yet. It had been a matter of some surprise how small was the resistance offered by British troops to the landing in England, and the question was often asked, " Where is the main British Army? " It now transpired that the troops captured in the transports on their way to Canada, were but a very small portion of the army, which, supplemented by a huge number of Canadian troops and volunteers, was now actually advancing from Canada southwards to invade the States. And all the flower of the American army was in captivity in England.

The Pacific, cleared of the enemy's ships, was alive with vessels bearing thousands of Australians and New Zealanders bound to assist their fellow-colonists in Canada.

This last shock was too much for the passionate monarch. The Emperor, on hearing it, fell unconscious into the arms of his private secretary. He was taken to his room, and medical men were promptly summoned. The gravest symptoms were manifest. Ministers and friends were urgently sent for. The Emperor's condition became more alarming. He rallied a little. His lips moved as if he wished to make a statement. At last his eyes opened, and with an effort he whispered " Libertia! " She was kneeling at his side and holding his hand. Many of the principal ministers and friends of the great man were grouped around. " Libertia," he hoarsely whispered, " tell the people of England that they have misjudged me. Wrong I may have done—often—but not such bad things as they accuse me of. That villain, Bateson, brought it all about. Would that I had been able to exonerate myself in their eyes. Tell them this." There was a long pause as all looked steadfastly on in solemn silence. At last he gave one heavy sigh, as of relief, and expired.

CHAPTER XIII.

Peace and Concord.

A few days afterwards the following proclamation was eagerly read, not only through the United States, but throughout the British Empire, and, indeed, by all the civilised world:—

" Citizens of the United States,—I, your Empress by inheritance, crave your attention.

" War, that awful heritage of mankind, bringing death and misery to millions, is raging wildly in our midst. War, whose only good is the suppression of the wrongdoers and weaklings of this earth, to demonstrate and maintain the survival of the fittest, is now manifesting itself as a death struggle between the two mightiest nations of the globe. Between the mother and her child. Between brothers of the Anglo-Saxon race. Why should this continue? What real good can come of it? Does it not bring to both nations only sorrow and degradation?

" Then, I ask you, I beseech you, I *command* you, stop it! It lies with you, the people, whose mind must be considered even by their sovereign. Think of it each one of you. Consider it in all its aspects. Shall we gain by the suppression of our neighbours? What good would it do to each one of us personally to annex their territories, already so well ruled over, so judiciously managed?

" Is it not a sin to continue such bloodshed, to sacrifice so many lives of noble, able, and accomplished men?

" Then let us end this strife. Let us shake the hand of peace and settle down once more to carry on our commerce, to bring happiness to our homes, to foster learning and industry, to better mankind instead of butchering it.

" I am, therefore, appealing for peace to that august ruler of the nation which we all should love, our kith and kin, that nation with whom we ought to go hand in hand to lead the civilised and uncivilised nations of the world and show them an example of how peace and freedom should be maintained.

" Libertia."

These soul-stirring words from the heart of the young and beautiful Empress made the greatest impression on all who read them. Both nations had suffered greatly. Both had been humiliated, and but one opinion, strongly in favour of the proposed action, prevailed. In England it was the same. An armistice was promptly proclaimed, and within a short time a reasonable settlement arrived at, and a great Treaty confirmed, binding the two nations eternally to a close alliance for amicably ruling the world.

One more scene in London and this short history is ended.

It was a glorious day in June. That huge central street of London, the pride of Englishmen, the triumph of housebuilding man, was ablaze with many-coloured bunting. Triumphal arches, flags, and banners, large mottoes of welcome, and coloured designs met the eye on every side. All this betokened a nation's heartfelt welcome to a stranger—if stranger she could be called. Millions of English, old and young, had assembled to greet her, for the Empress Libertia had responded to the call of the British voices, and now arrived in their midst, a pure type of royal womanhood, the bearer of her dead father's last message.

Not forgetful of a day, many years ago, when that lovely young form had knelt to Royalty, the Hope of England's future, the Prince whose destiny was mingled with that of the people, now looked upon this prepossessing maiden. Their hearts' strings were struck with a synchronous chord, and soon the nation learned with joy that in her he had sought and found his bride. The union of the Empress of America with the heir to the British throne cemented even closer the unity, peace, and concord, so happily inaugurated between the two mighty nations.

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Photographs of the Canals on Mars.

READERS of "KNOWLEDGE" are mostly aware of the discussions which have from time to time arisen as to the reality of the markings on the planet Mars of the nature of fine lines, and which some suppose to be canals. It has been suggested that these, instead of being distinct lines, are but the edges between gradations of half-tones (*vide* "KNOWLEDGE," November, 1903). Another theory is that they are the effect of a number of minor detached markings and not continuous lines. If, then, a photograph could be taken sufficiently distinct to make out these markings the question could be settled definitely.

In May last the important announcement was made by Mr. Lowell that the "canals" had been actually photographed by Mr. Lampland at the Lowell Observatory, Flagstaff, Arizona. Persistent endeavours had for some time been made to secure such photographs, but great difficulties were encountered. Eventually a number of exposures were made on a continuous film with short exposures, similar to that of a cinematograph. On examination a number were found to show the canals, thus demonstrating indubitably the actual existence of the canals, or, rather, the fine lines on the surface.

Mr. Lowell has now been good enough, at our request, to send us some specimens of the actual photographs. The reproduction which we give herewith may seem somewhat disappointing, but, as may be imagined, the extreme delicacy of the lines, which, though discernible under a careful examination of the original negatives, can hardly be reproduced in an ordinary photographic print, much less in a half-tone block. This little picture will, however, give some idea of the size and nature of the plate, and beside it are reproduced the careful drawings which Mr. Lowell has made from the original photograph.

This view shows the Sinus Titanum region, and the following canals are visible in Mr. Lampland's photograph:—

Erebus	Gigas
Helicon	Laestrygon
Cerberus	Pallene
Styx	Boreas
Eunostos	Arion
Orcus	

At the bottom of the right of the central point in the photograph a projecting nipple may be noticed. This was the first beginning of the new Polar Cap, and was then only thirty-six hours old.

The telescope used was a 24-inch refractor.

The planet, at the time these photographs were taken, only presented a diameter of about 15 seconds of arc, and in order to secure the necessary definition only the central portion of the 24-inch object glass of the telescope was used, a diaphragm being interposed so as to give an effective diameter of 12 inches. A colour screen allowing only the orange and yellow rays to pass was also employed.

The Lowell Observatory at Flagstaff is situated at an elevation of 7250 feet above sea level, and in a particularly clear and dry atmosphere, so that the conditions are such as can hardly be obtained at any other observatory.

Much Reduced

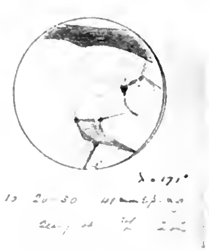
λ = 194°

May 20, 10h. 42½-45m.

Photograph by C. O. LAMPLAND.

λ = 171

Reduced.



λ = 171

May 22, 10h. 20-30m.

Reduced.

λ = 190

May 20, 10h. 25-40m.

Drawings by PERCIVAL LOWELL.

λ Martian meridian central at the time

Coast Denudation in England.

By Edward A. Martin, F.G.S.

Part II.

As already pointed out, no part of the coast has suffered more greatly than where the cliffs consist of deposits of loosely-compacted sand and clay, and as scarcely any geological formations other than of tertiary and quaternary age are found in this condition, hence it is where these deposits are exposed to the sea-action that the erosion is most felt.

Probably nowhere has denudation proceeded more rapidly than on the Holderness coast of Yorkshire. Various estimates have been framed of the extent to which the coast suffers in this part, and the encroachment of the sea has been estimated at so high a figure as 30 feet, and by others at so low a one as 6¼ feet, per annum. Probably an average rate would be found in that estimated by Mr. T. Sheppard, F.G.S., for the coast between Spurn Head and Bridlington, namely, 7 feet per annum. Between these two many ancient villages have disappeared—Wilsthorpe, Auburn, Hartburn, Hyth, Cleton, Monkwell, &c.—and in some cases the names remain only as applied to modern spots which were formerly inland. Observations which have been made at Dimlington show that during the last few years the average yearly rate of erosion has been 10½ feet, and at Out Newton some ruins of an old chapel may be seen which were, in 1833, 147 yards from the edge of the cliff. South of Kilnsea, where the low boulder-clay cliffs are about 10 feet in height, the cliff dies away altogether, and were it not for the protecting groynes which have been built by the Board of Trade, erosion here would probably be considerably greater than it now is. Mr. E. R. Matthews has made some interesting calculations as to the weight and extent of the area denuded. Many estimates have been made, and these will always differ to a very great extent, depending in the first place on the assumed rate of denudation, then the average taken for the height of the cliffs, and the average weight per cubic foot of the materials constituting the glacial beds of which the cliffs are formed. The estimated weight of the deposits removed has been placed at three millions of tons per annum, whilst Mr. Matthews places the area which has disappeared since 55 B.C., the date of the Roman invasion, at 115 square miles, or nearly the equivalent to that on which London and Greater London stands. Looking at it all from a geological point of view, one must bear in mind that the sea is only now encroaching upon what formerly belonged to it. The deposits which are now suffering are accumulations of boulder-clay and glacial moraines which had no existence in tertiary times, and up till the beginning of the glacial period the coast-line ran considerably further inland than that to which the sea has even now attained. The sea at that time approached closely the line of the eastern boundary of the chalk, which runs south-west from Flamborough Head in the direction of Driffield and Beverley.

An interesting question which has puzzled observers is, What has become of all the eroded material? The silting-up of the Humber is, to a large extent, due to its deposition, together with the growth of Spurn Head; and as it is denied by some authorities that any of the silt is carried forward to the Lincolnshire coast, it would seem to follow that protective measures, if taken effectively along the whole of the Holderness coast, would go a long way towards keeping a fair-way always open in the Humber Channel.

Another portion of our eastern coast-line which is suffering at the present day, and has, indeed, suffered as long as history can record, is that which extends from the northern coast of Norfolk along the Suffolk and Essex coasts to the Thames estuary. These, again, expose to the sea cliffs of but a partially-coherent material, affording little or no protection to the battering-ram action of the waves. The deposits here formed are partly of glacial age, chalky boulder-clay being the principal material, and partly of Pliocene age (late Tertiary), the latter being known as the "crag" formation. In Essex the London Clay (Eocene Tertiary) has cropped out from beneath the crag, and this, although of a more coherent nature than the other deposits mentioned, affords but little more resistance to the eroding power of the sea. So when one leaves the chalk of the north of Norfolk we see, going southward, a gradual falling away in a south-westerly direction of the coast-line, and this only comes to an end when we reach the Thames, whilst on the south side of the estuary we find raised as a bulwark against similar denudation the uprise of the chalk. The fault which occurs in the bed of the river, and which has let down the strata on the north side to a lower level than those on the south, besides probably deciding the position of the embouchure of the river, has exposed the low-lying northern coast to the immediate action of marine denudation. Thus the whole East Anglian coast is subject to continual erosion.

A map is preserved in the Yarmouth Town Hall, copied in the time of Elizabeth from an earlier one, which purports to show the coast hereabouts as it was in the year 1000. At that date the site of what is now Yarmouth appears to have been but a sandbank across the entrance to a wide estuary, extending up to Harleston and Norwich. Considerable concern is now felt lest, by the removal of the comparatively narrow line of cliffs, a similar state of affairs may again come into existence, and the low-lying land of East Anglia become permanently flooded.

We have seen that Holderness has probably come into existence since the glacial period, and in these eastern counties again we see wide stretches of low lands intersected by broads and sluggish streams, which show to the practised eye that the period is not far away back in geological time when the sea stretched away inland, covering those parts where subsequently the boulder-clay came to be deposited. The question of erosion is a burning one, but it must be borne in mind that a considerable area was wrested from the sea in those pre-historic times, when Britain's natives witnessed the passing away of the glacier mantle which had covered so much of the country.

Although the coast of Essex has no doubt suffered much in the past, and the products of its denudation have been spread over the sea-bottom in such a way as to shallow the sea for some considerable distance from the land, modern erosion is not now so serious a matter as it must have formerly been, in view of the extensive mud flats over which the incoming tide pursues its way. But when one sees the evidences on all hands along the coast of the former existence of a much greater population than is now there to be found, there is good reason to think that many a flourishing village has been lost in the sea. The spreading out of the *débris* in the form of mud flats leads in the course of time to a contrary movement, with a possibility of reclamation, by the building or raising of some kind of wall around areas covered at high tide. Such appears to have been done, for instance, around the mouth of the river Crouch.

Apart from the steady planing down of the coast, there is in East Anglia the additional danger of inundation. Some of the rich grazing grounds here are low-lying marshes, protected only by low cliffs. The recent fall of cliff at Pakefield, near Lowestoft, composed of boulder-clay, is but another instance of the gradual denudation of the cliffs, which, if not checked, must in the long run threaten the broadlands with inundation by the sea. There is every reason to think that before such a catastrophe could take place the protection of this portion of the coast would definitely be regarded as a national duty, and this might prove a first step towards the formation of a special Government department, having as its *raison d'être* coast protection in general.

In considering the disappearance of our cliffs we are not just now concerned with the loss of land in the pre-historic period, which was owing purely to a subsiding movement of the whole country. Of such a widespread movement we have ample evidence in the numerous submerged forests, of which traces are observable at abnormally low tides. That the subsidence was of a gradual and tranquil nature is shown by the very existence of such remains. The features of a land surface are apt to become effaced immediately the play of the waves commences to be felt upon it, and even under the most favourable conditions many of the trees would become washed out of the soil, whilst others would be broken off short, so that their stumps alone remained. But loss of land through subsidence of the crust is a thing against which seaside authorities and Government departments might rage in vain. On the other hand, similar loss by erosion or denudation can be guarded against, and this is what is now so eminently desirable.

The Isle of Sheppey has been from time immemorial gradually slipping away into the sea, and the rich harvest of semi-tropical fossil fruits, turtles, &c., from its London Clay cliffs have enriched many a museum. A few miles farther east, on the North Kent coast, we see the wide stretch of flat meadow-land which extends in a south-easterly direction towards Richborough, marking the silted-up bed of the water-way which formerly divided the Isle of Thanet from the mainland. But with the destruction of the tertiary cliffs at Reculver it is probable that the sea would already have commenced to reassert its right to the old channel were it not kept back by artificial embankments. The Sister Towers, which were, two centuries ago, at least a quarter of a mile inland, now stand at the edge of a sea wall, reared by the Brethren of Trinity House.

The Isle of Wight is, geologically considered, but an outlier of the mainland, but the only historical reference to its former connection with England is contained in that much-quoted passage in Strabo, alleging that carts laden with tin used to pass to the island at low tide, in order to ship that much-prized commodity off to Phœnician markets. If one takes one's stand upon the Downs near to Tennyson's monument, and looks northward at low tide, one can easily conceive this to have been the case, seeing that in addition to the spit of land on which Hurst Castle is situated, numerous banks show themselves above low-water mark, and these are undoubtedly the remains of a connecting link, which must have been apparent not many centuries ago.

The broken condition of the coast between Alum Bay and Colwell Bay give evidence of great falls of cliff within modern times, and, indeed, geologically considered, there is no doubt that only a short time ago the Solent was but a river which emptied itself into the English Channel some distance beyond the Needles. At this time the gradual erosion of Spithead, which was going on, had not accomplished its work, and a bay stretched out between Selsea Bill and Culver Cliff. It is not a little remarkable in this connection that off Selsea there is an anchorage which is even now known as the Park. Probably the scour of the up-Channel tides had a good deal to do with the erosion of the bay, and even now the same action is responsible for a phenomenon here, which is found only at one other place on the south coast, namely, the movement of the shingle from east to west instead of from west to east. To the same cause may probably be attributed the arrival in glacial times of the numerous boulders of granite and other rocks foreign to the neighbourhood, which have been seen at low water on the Selsea coast. That erosion of the opposite coast on the island is still in progress is shown by the fall of tertiary cliffs which are frequently reported from Brading and the neighbouring east end of the island.

Wherever the coast-line is made up of soft or incoherent materials, from those parts comes the strongest call for protection against the inroads of the sea. On the iron-bound coasts of the west the battering-ram action of the sea has comparatively little effect. The submergence of Lyonesse, and the development of the hundred and fifty islands of which the Scillies consist, cannot positively be attributed to erosion any more than can the severing of St. Michael's Mount from the mainland. Possibly in both of these cases, as also in that of the development of the Bristol Channel, the present contour has been brought about by actual subsidence.

But it is on the south and east coasts where land is lost. The Oligocene and Eocene of the Isle of Wight; the Thanet Sands of Pegwell Bay; the Oldhaven Beds and Woolwich Beds of the Herne Bay coast; the London clay of Sheppey; the Red Crag (Pliocene) of Suffolk; the boulder-clay of East Anglia and of the Holderness district of Yorkshire; from all of these there comes the news of constant denudation, and it is in respect to some of these that Government action will have first to be taken, if the matter ever comes to be regarded as one in which the State should interfere.

New Radioactive Element.

Mr. Oskar Kahn, in fractionating a mixture of bromides obtained from thorianite, found that whilst the radium accumulated in the least soluble fractions, the radioactivity of the most soluble portions also increased. A strongly active oxalate precipitate of about 10 mg. was finally obtained, which glowed faintly in the dark and excited the platinocyanide and zinc sulphide screens in a marked fashion. If a current of air is blown through a solution of the substance and directed against a zinc sulphide screen, the illumination of the latter is somewhat similar to that observed in a parallel experiment with emanium. It is shown, however, that the substance cannot be actinium or emanium. The emanation from the substance is almost identical with that of thorium, but the substance itself is from 100,000 to 200,000 times as active as thorium, and is supposed to contain a new radioactive element.

The Coloration of Mammals and Birds.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S., M.B.O.U., &c.

(Continued from page 343.)

We will now turn to the second part of this paper, which deals with the markings on mammals and birds, our object being to show that throughout these groups certain spots on the body will be found to differ in colour from the neighbouring parts, although in many cases the differences will be either so slight or so transitory in their nature that they cannot be said to serve any of the purposes usually ascribed to the agency of natural selection.

The conditions instrumental in bringing on a moult in mammals and birds are to my mind very obscure. A high temperature is undoubtedly a stimulating cause, as birds can be made to undergo a moult by merely keeping them in a warm atmosphere, but it is also necessary for a *successful* moult that the vigour of the animal should not be at too low an ebb, though, on the other hand, it need not necessarily be very high. The state of its "vigour" at the time of moult is visible in the *colour* of the new coat, rather than in a suppression or suspension of the moult. And birds in captivity in bad health will often show a tendency to become white. Nevertheless, it cannot be denied that moult is closely dependent on "vigour"; for although the moult will not be omitted if an animal's vigour be very low, yet the attempt will prove abortive and the animal will die. So that an animal cannot successfully moult without a certain amount of "vigour," but a moult will be attempted at certain fixed seasons, irrespective of that "vigour."

Shortly before a moult takes place an alteration will be visible in the colour of many mammals and birds; this alteration is always in the same direction, namely, a lightening or, as it has been termed "bleaching" of the hairs or feathers, followed (and this is especially noticeable in the latter) by a breaking up and complete disintegration of structure.

I have referred to this matter in two previous papers,* but it may well be dealt with more fully. It has been generally assumed that this "bleaching" process is gradual, and due to the action of weather and light alone. This, as I hope to show below, is not so; the actual disintegration may be brought about by the action of weather and light alone, but, if so, only after the hair or feather has been physiologically disconnected from the living tissues of the body. This latter process generally, but not always, takes place when a new hair or feather is beginning to be formed.†

One example of this is to be found in the so-called "white tail" assumed in summer by our English squirrel. Unlike the rest of its body, the tail is not moulted in spring, but shortly after the spring moult the tail begins to turn to creamy white, beginning at the tip and gradually spreading towards the base. Now, if this were merely due to the action of light, the "bleaching" would go on equally all over the tail, but this is not the case.

Of this form of "bleaching," which usually precedes a moult, I could instance numerous examples. In the case of the *Anatidæ*, or ducks, in which group all the primaries are moulted at the same time, the bleaching of these takes place about a fortnight before they are cast, the whole process taking ten days, or at the most, a fortnight, and yet during the first eleven months of their existence the change in colour was hardly noticeable.

This process of bleaching, however, need not always be caused by an approaching moult. I had a striking case some eighteen months ago exemplified by a *Gadwall*, which began to bleach about a month after he had moulted. In the course of a fortnight his wings and most of his body feathers were of a light dirty brown, and at the end of a month most of his feathers were entirely disintegrated and in shreds. I need hardly say that he was in very bad health. In the ordinary course of events these feathers would have lasted ten months practically unaltered, so that this disintegration cannot be put down solely to external causes. At the following moult the feathers were perfectly renewed.

The so-called abrasion of the tips of hairs and feathers is another cognate case, for, although it is generally assumed that the tips *gradually* wear off during the winter, I can, as regards birds, positively state that this is not so. To take a single instance out of many that suggest themselves. In the reed bunting (*E. schœniclus*) the black bases to the feathers of the head will be obscured by the brown tips throughout the whole winter down to the middle of March, and yet, during the three weeks from the middle of March to the end of the first week in April, those tips will suddenly be lost and the whole bird will become brighter, this change taking place without the presence of a moult.

Is it probable that these tips, which have withstood the winter storms, should be washed away by April showers, unless there was some active physiological process behind it?

Many more instances could be quoted, but enough has been said to make it clear that "bleaching" only takes place when permitted to do so by physiological agency.

In my former papers, quoted above, several groups of squirrels in which the "bleaching" is marked were referred to, and it was pointed out that it was quite absent in some species and present in varying degrees in others very closely allied and inhabiting practically the same country.

Let us now carry the matter a step further and we will endeavour to show that *bleaching* is the *origin* of many of the markings and longitudinal stripes among mammals and birds.

The oriental genus of squirrels, known as *Ratufa*, offers the best examples for a study of this question.

The typical *Ratufa bicolor* of the Malay Peninsula is a large squirrel, deep glossy black above and light yellowish below. The new coat when first assumed is always black, but "bleaching" soon sets in, although the extent to which it is carried varies greatly among different individuals. In some cases the whole body becomes deep rufous brown, the legs and feet remaining black, while the hairs of the tail show a few red

* *Ann. and Mag. Nat. Hist.*, 1900, Ser. 7, Vol. 15, p. 492. *Zoologist*, 1901, p. 243.

† The leaves of deciduous trees offer a similar, though not precisely analogous case. They turn yellow in Autumn as soon as the sap ceases to reach them and the coating of bark tends to disconnect them from the trees. No one supposes the yellow and brown tints of Autumn to have been a gradual process going on throughout the summer, it does not commence until the leaf is physiologically disconnected from the tree. Leaves on a broken bough undergo a totally different change.

tips.* Should it get still lighter, the hairs will be found to be annulated with pale red until finally one may get the hair of a dirty creamy white, showing no trace of colour whatever. This is pure "bleaching," possibly a thinning of the pigment, which may be withdrawn for the use of the body as has been stated to take place in the whitening of the Arctic hare†.

Let us now take a nearly allied species from the Natuna Islands off Borneo, *R. bunguranensis*, and here we find the whole of the body of a brownish colour with rufous annulations, while the under parts are uniformly dark ferruginous, but almost immediately a new coat is assumed we find a *patch on either thigh bleaching*, which process rapidly spreads until the whole body is light buff; the under parts, however, not being affected to the same extent.

On the mainland of Borneo we have another species, *R. ephippium*, noticeable for its purity of coloration, very few of the hairs having subterminal annulations. From the top of the head to the root of the tail runs a broad and very dark brown stripe, slightly lighter on the shoulders and spreading out over the posterior part of the body; the rest of the flanks, sides of the neck, face and ears, ferruginous, fading into pale orange on the limbs, feet, and throat, the colour being palest on the forehead.

In *R. baramensis*, a local form of the above, we find the colour practically the same but lighter. Thus, along the back, we find the majority of the hairs with light annulations, instead of being self-coloured, though self-coloured hairs are still to be found along the back and across the rump. The rufous colour has disappeared from the sides of the body except on the cheeks, and the limbs and feet are yellow.

In *R. affinis*, a species from the south of the Malay Peninsula, the new coat is very light brown all over with still paler annulations, which almost immediately bleach to pale yellow.‡

We find, therefore, that we have in *R. bicolor* a species which in a new coat is pure black, but a species which, owing to bleaching, becomes very variable with light patches on various parts of its body, and, further, that other nearly allied species will have their colour permanently differentiated in lines and patches situated in places similar to those in which *R. bicolor* "bleaches."

Now, although in *R. bicolor* the amount of "bleaching" among various individuals may vary, yet the light-coloured patches will all start from certain definite "centres of bleaching," where "bleaching" will always first show itself, though it need not necessarily take place in all of them at the same time.

These parts of the body, which are "centres of bleaching," I propose to call "**poecilomeres.**"

* Although rather beside the point it may make the matter clearer if I explain that in most animals the colours belong to one of two series, the actual shade of colour depending on the amount and concentration of the pigment. The series are: (*a*) White, clay, light brown, dark brown, black (zoomelainn). (*b*) White, yellow, orange, red (zooerythrin), and in a very concentrated form, black. It will thus be noticed that black may be apparent from either of these series. This will, I think, tend to explain "erythrism," a common variation among squirrels where they tend to become red, and will account in this species for red tips appearing on the black hairs when they begin to lighten. It also affords an explanation as to why the allied species tend to be red and white in their general coloration, e.g. *S. caroli* rather than black and yellow as in *R. bicolor*.

† *Barrett-Hamilton, Loc. cit.*—p. 307.

‡ For full descriptions of these species as well as of some to be mentioned hereafter see my papers in *Ann. and Mag. Nat. Hist.*, Ser. 7, Vol. 5, p. 400 (1900), and Ser. 7, Vol. 7, pp. 167, 169 (1901).

The "poecilomeres," so far as *R. bicolor* is concerned, are situated as follows:—

The shoulders and thighs.
The crown of the head.
The tip of the nose and lips.
The tip of the tail.

In true *R. bicolor* one may find all variations. Sometimes the lightening process will start at the crown of the head and spread gradually over the back, becoming quite light across the shoulders and darker on the after part of the back, leaving the feet and legs black. At other times, starting from the shoulders and thighs, the bleaching will spread down the legs, leaving the body black and the legs light, the reverse of the previous case, or, sometimes, owing to the *thigh poecilomere* spreading forwards, a narrow light line will be formed between the colour of the back and the under parts.

In *Sciurus rufoniger*, a Sumatran squirrel of the *S. erythraus* group, we find this thigh bleaching rather more restricted and leaving a dark line of the colour of the upper parts between the "bleached" portion and the under parts. In this case we see, therefore, the beginnings of a dark as well as a light lateral line.

Now suppose, instead of these changes taking place during the life of the animal, that they should have become fixed and that the animal is, in consequence, born with a so-to-speak "bleached" pelage. The hair will not, strictly speaking, be "bleached," but it will differ in colour from the remainder of the body in the places where the poecilomeres should be. *Sciurus prevostii* and *Sciurus caroli* form very good examples among the squirrels, but the matter may be carried further than that; the white and black lateral stripes of the antelopes, the white lips of the same group, the white "blaze" of domestic horses and cattle, the white lips and feet of many ungulates, the starting point of the white back of skunks and ratels, the reddish thighs of some African jackals, white legs of the fox and polecat, light muzzles of many bears, light frontal patch of Bos frontalis; and among birds, to note but a few, the light patch above the beak of the white-fronted goose and the scaup duck, yellow on the crown of the golderest and many tyrants, light wings of pheasants, &c. Examples might be multiplied for ever, but enough has, I think, been said to show that these "poecilomeres" are of sufficiently wide occurrence to render it practically certain that they are due to something more than mere coincidence, and I suggest that we see their earliest beginnings in the "bleaching" of *Ratufa*.

As we examine more specimens it will be found that although some of these "poecilomeres" may be traced in almost all species that are not self-coloured, they will not always be *lighter* in colour than the rest of the body, but often, on the contrary, spots of more intense coloration, *e.g.*, buttocks of many monkeys, shoulders of the panda, forehead of okapi, red "blaze" of the goldfinch, red on occiput of many woodpeckers, &c.

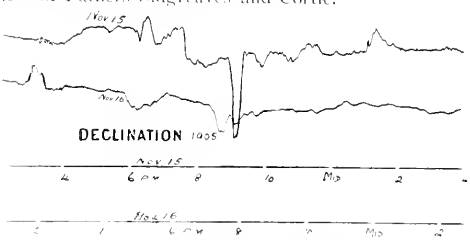
We cannot give a thoroughly satisfactory explanation of this at present, but if it be once thoroughly established that (as Prof. Metchinikoff and Mr. Barcroft have proved for man, the dog, and the hare) colour may be, and is, extracted from the hair for the use of the body, it is only natural to suppose that any superfluous colour (supposing the pigment to be of nutritive value to the body) would be stored up where it might most easily be got at, should the body require it. Much more information is, however, required before this can be positively stated.

(To be continued.)

The Aurora of November 15th.

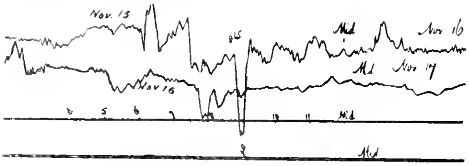
By W. SHACKLETON, F.R.A.S.

IN view of the wide-spread area over which the aurora of November 15 was observed, together with the simultaneous disturbance of the magnetic needle, it seems desirable to add to the few particulars given on page 293 in the issue of December last. Observations of the aurora are recorded from Vardo, Christiania, Szczawnica in Galicia (Karpathian Mts.), Wilhelmshaven (Germany), many places in France, England, and Ireland, and also from Nova Scotia; thus practically the whole of the northern parts of this hemisphere that were in darkness at the time of the occurrence have recorded the phenomenon. Most observers agree that the aurora was at its maximum about 9 p.m. (Greenwich time), but Mr. Roberts, writing from Welshpool, states that he observed a fine display, with a maximum brilliancy about 6.10 p.m.; others also record this. In Nova Scotia displays are recorded as taking place about 6 p.m. and also about 9 p.m. (Halifax time). From these observations it would appear that several displays occurred on the same date. The earlier display is probably coincident with an easterly movement of the declination needle, but the one coinciding with the greatest disturbance is the display observed about 9 p.m., and curves from the magnetic observatories of Wilhelmshaven, Kew, and Stonyhurst, all exhibit precisely similar deflections. Through the kind permission of the Director of the National Physical Laboratory, Dr. Chree has supplied us with copies of the Declination and Horizontal Force curves taken at the Kew Observatory, and a similar declination curve is exhibited from Stonyhurst College through the kindness of Fathers Sidgreaves and Cortie.



Declination Curve, Kew, Nov. 15th.

It will be seen that about 9 p.m. a rapid easterly movement of the needle began, reducing the declination some 32′ in about 15 minutes, followed by an equally rapid return to the normal.

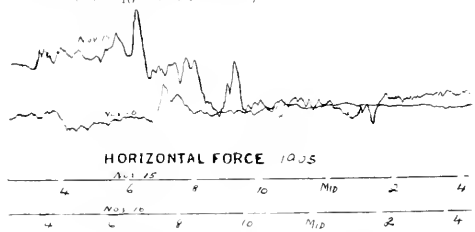


Declination Curve, Stonyhurst, Nov. 15th.

* Two days' records are taken on each photographic sheet, the upper is the earlier. The base line is the time scale.

The similarity of the curves is obvious, and Dr. Borgen, Director of the Magnetic Observatory, Wilhelmshaven, states that the large disturbance showed itself, in the same way, on the magnetic curves taken there.

The disturbances of the declination needle were accompanied by a sympathetic movement of the horizontal force magnet; the most prominent displacement, however, coincides with the aurora observed in the early evening, when the horizontal force increased by 105γ in about 10 minutes, and then fell 150γ in the next 20 minutes ($1\gamma = 10^{-5}$ C.G.S. unit).



Horizontal Force Curve, Kew, Nov. 15th.

After the disappearance of the aurora the needles continued to be disturbed, but not so violently, for about 30 hours.

Of the many theories put forward in explanation of the origin of magnetic disturbances, one naturally associates these particular ones with the co-existing auroræ.

The aurora of November 15 was particularly interesting on account of its vivid crimson tint, a type of aurora which is not common, the whitish yellow auroræ being more frequent. Observations from favourable localities like Vardo, state that the aurora was by far the most splendid seen for many years. Strong auroræ of this kind are rare in England, and it is a matter of regret that so few spectroscopic observations are forthcoming, especially as the origin of the auroral lines is not definitely known, in spite of the researches of Capron, Vogel, Huggins, Paulsen, and others. Usually, however, it is inconvenient to put aside a spectroscope suitable for this kind of work in the hope of an aurora coming along, and this may account for the scarcity of observations; yet every observer who looks for auroræ should be provided with a spectroscope, for it is well known that the aurora line is visible spectroscopically when the naked eye fails to detect any display, and, again, many reputed auroræ would be shown to be mere sky reflections if spectroscopic observations had been made.

Both Professor Fowler and myself made independent spectroscopic observations, but neither of us were able to bring a spectroscope to bear upon the display whilst the crimson rays lasted, and no trace of a red line was seen, though special search was made.

The common aurora line at λ 5,572 was very strong, and remained visible till midnight (as long as observations were continued), whilst, in addition, three other faint and more refrangible lines were seen.

The spectrum of the aurora is most probably a variable one, although the green line is persistent, but the phenomenon of gases exhibiting different spectra according to the nature of the electric discharge is common, and it seems probable that the various tints of auroræ may be accounted for by the varying electric discharges through some gas in the upper reaches of our atmosphere. The nature of this gas has not been definitely origined, though Krypton seems to hold out the most promise.

Another theory advanced to explain the cause of auroræ is the pressure of light repelling some of the corpuscular matter surrounding the sun until it reaches the earth's atmosphere, the electrons being directed into the magnetic Meridian by the influence of the earth's magnetic field.

Whatever be the cause and nature of the aurora, there appears little doubt that auroral displays are very frequently accompanied by magnetic disturbances, though the converse does not hold.

CORRESPONDENCE.

The Evolution of the Flower.

To the Editors of "Knowledge & Scientific News."

Sirs,—There are a few rather important oversights in Mr S. L. Bastin's paper on the above very interesting subject, which I venture to suggest might be mentioned, as well as a few additions made; for since the paper is evidently intended for beginners in Botany, a few extra remarks might supply an additional interest to the subject.

Comparing the use of flowers with vegetative methods of propagation, the latter is often much more important than the reader might, perhaps, suppose. Of course, annuals depend entirely upon seed; but perennials often multiply for far longer periods than might be inferred from the expression, "for a time at any rate." This may be enlarged to upwards of a century—*e.g.*, with *Oxalis cernua*, introduced into Malta from the Cape before 1804; for it has spread, and is still doing so, by means of bulbs, along both north and south shores of the Mediterranean Sea, but never sets seed at all throughout that region. Our pilewort, too, rarely seeds.

The object of Mr. Bastin's paper is to show that the four organs of a flower—the sepals, petals, stamens, and carpels—are fundamentally "homologous" with leaves; *i.e.*, they might have grown out into true leaves had they not appeared as these organs. A little modification is here required; for it is rare to find the sepals, for instance, as representing a *whole leaf* or stalk and blade together. It usually corresponds with the stalk or "petiole" only, as may be readily seen in a rose. Very occasionally is a sepal the same thing as the blade, as in the corn-cockle.

Similarly, petals usually correspond only to the "filament" of the stamens, so well described by Mr. Bastin in the Water-lily or in Canna; but in the Ranunculus family it is the "anther" of the stamen which is converted into the petal. The student should compare the "nectaries" of *R. auricomus*, *R. Ficaria*, and other species, and he will soon discover *transitional forms*, showing that while one half, the outer, of the anther grows into the broad yellow petal, the other, or inner half, remains arrested, like a tiny flap; in the spot between the two, corresponding to the bottom of the anther-cells, honey is secreted.

The little honey-pots of Hellebores and Winter Aconite are similarly constructed out of anthers.

The "spurred" petals of the Columbine afford another good illustration; while in "double" Columbines the numerous "spurs" of the converted anthers fit into one another in radial rows.

In the "green rose" and Alpine Strawberry every part of the flower is represented by a small green leaf; some of them may still carry an anther-cell showing, as Mr. Bastin explains, their true homology.

The first stage, therefore, was the conversion of leaves or "leaf-scales" into carpels and stamens. This stage is seen in the *male* flowers of Juniper and Cypress, though, unfortunately, we have no good case of a "Gymnosperm" passing into an Angiosperm, the former having no indisputable representation of a "carpellary leaf" at all.

The second stage was to construct petals out of stamens, as stated.

In all the above plants mentioned the organs are "free," but "cohesion" often stepped in and united the parts of the "whorls" together. Mr. Bastin alludes to Campanulas in illustration, but here the five united petals make the bell, while the five sepals are external to it, and more or less joined together, but not to the petals to form the bell (which has only five free tips) as suggested by Mr. Bastin. Indeed, in a garden variety called the "Cup and Saucer," it is the broad, flattened out blue calyx which makes the saucer, while the corolla is the cup within it.

It sometimes happens that the sepals of flowers are white or coloured, as Mr. Bastin observes. Then they *look like petals*, and are called "petaloid." Such is the case with several members of the Ranunculus family, as *Clematis*, *Anemone*, *Calha*, *Aconitum*, and *Delphinium*, but *they must not be confounded with petals*.

When such flowers become "double," it is not the sepals which multiply, but the petals, together with the stamens and carpels, which latter are now represented by petals, of which the whole number may be upwards of fifty, as in a stock, and many more in a garden Ranunculus.

In Monocotyledons, such as tulips and hyacinths, the sepals and petals had better not be described as "identical," except as to colour and form.

Botanists regard them as being *two* distinct whorls, the outer and the inner, at least when the parts are not united as in a tulip, but they may be united as in the garden hyacinth. Nevertheless they should be regarded really as 3 + 3 rather than 6 in one whorl.

Bracts, too, are rudimentary forms of leaves, being either homologous with petioles only, as in Hellebores (*H. fœtidus* is an excellent illustration of a perfect transition in the reduction and loss of blade, with a diminution of the petiole into a bract) or of the blade only, as in Buttercups.

Sometimes the bracts are brightly coloured and may puzzle beginners. But they are always *outside* the flowers, often including *several flowers*, as in Euphorbias and three in Bougainvillea, a proof that they are not really parts of a flower.

They not infrequently mimic a flower. Thus species of *Cornus* has four large white bracts, numerous minute flowers being within them. It thus looks like the flower of a Clematis, which may have four white sepals. A species of Euphorbia has five rounded scarlet "glands," exactly imitating a five-petalled flower!

It is only by a careful examination, which the beginner should always make, before the imitation is detected.

All these coloured organs, as Mr. Bastin rightly observes, are to attract insects for pollenation. Nature sometimes goes so far as to put all her energy, so to say, into the corolla, as to even sacrifice the stamens and pistils. Such is the case with the outermost flowers of a truss of *Hydrangea*, which has only a coloured calyx, and the Guelder-rose, which has only a corolla. Such, too, is the case with the large trumpet-shaped "ray" florets on the head of a *Centaurea*. The outermost flowers of these plants have sacrificed their power of setting seed for the benefit of the community, consisting of inconspicuous but fertile flowers in their midst.

As sepals, petals, stamens and carpels will sometimes "revert" to be represented by true leaves, so may bracts. It is not uncommonly so with plantains. Each of the numerous, minute flowers which form the dense spike, stand in the "axil" of an extremely minute bract. Sometimes, however, these bracts become "foliaceous" and grow out into small leaves.

In the "Green Dahlia," the usually colourless bracts or scales, hidden among the flowers, become large, thick and green, all the florets being totally arrested. This change is expressed as the result of the "law of compensation," when one organ is enlarged at the expense of another; but why these changes take place is a problem which cannot always be solved; but the lesson we learn from all this is, the wonderful power Nature possesses of constructing any organ she pleases out of any other. It is not only in flowers, but a general capability, and is most admirably seen in such curious adaptations as the means of climbing and of catching and devouring animal prey, &c.

George Henslow.

To the Editors of "Knowledge & Scientific News."

Sirs,—After reading Professor George Henslow's letter, in which he takes me to task for certain omissions in my paper, "The Evolution of the Flower," I am led to think that he can scarcely realise the vastness of this subject. Why, the additional examples which he thinks should have been included might be multiplied by one hundred fold! Moreover, several of the points to which he alludes were hinted at in my article, but space would not permit of their enlargement.

If Professor Henslow will refer to my text he will notice that after remarking that the sepals and petals of the Tulip flower are identical, I have placed the saving clause "as far as the ordinary observer can say." I am glad that

Sutton & Sons. Reading.

Gloxinia. "Cup and Saucer" Variety.

attention has been called to the error which has crept in by an oversight regarding the sepals and petals of Campanula flowers; of course, the "bell" is only formed of the petals, the calyx being quite distinct. The same point is illustrated in the tube-shaped flowers of the Gloxinia, an interesting "cup and saucer" variety of which has been recently introduced. By the courtesy of Messrs. Sutton and Sons I am able to send you a photograph of this remarkable form.

I should like to thank Professor Henslow for his elaborations of many points concerning which I had to deal all too briefly.

Yours etc.,

S. Leonard Bastin.

February 13, 1906.

The Green Flash at Sunset.

To the Editors of "Knowledge & Scientific News."

Dear Sirs,—Having seen a letter in your last issue (February, 1906) concerning the so-called green flash at sunset, I think it may be of interest to the writer of the letter and some other readers to hear of some of my observations on the phenomenon. Therefore, I am sending some extracts from my notebooks. The last one is especially interesting, as the position of observation and weather were very favourable, and also as I was expecting the occurrence. From the descriptions in my notes, I feel quite sure that the phenomenon is not an optical illusion, but an objective reality caused by the refraction of the air which acts like a prism upon the last rays of the setting sun, giving rise to a series of colours as observed ranging from the red to the extreme violet end of the spectrum.

I have noticed the same red flashes in Venus, and also Jupiter and several other stars when I have seen them setting behind the mountains in Egypt, near Assouan.

I have seen the green, or rather many-coloured, flash also behind the mountains at sunset in Egypt; but it is neither so clear nor of such long duration when seen over land as over sea.

Here are the extracts:—

1902, March 29.—Sunset well seen, vivid blue line (at sea, near Alexandria).

1901, Nov. 17.—Sunset, last arc disappeared 5 hrs. 2·2 min. ship's time off Corfu or Ionian Islands (not in sight). (At sea.)

1902, Feb. 2.—Venus set over mountains about 6.40 p.m. (Cairo time) at Assouan. The red colouring on the crescent in flashes was conspicuous.

1903, Aug. 31.—At Scourie, Sutherland, N.B., and Lat. 58° 21′ N. Long. 5° 9′ W.

7.25·5 p.m.—At the last contact of the sun's upper limb, the "blue line" appeared. When the sun's *lower* limb was about 15′ above horizon, it appeared intense red.

The blue line began to show evidence of its coming about 30 seconds before the sun disappeared. At first the whole of the visible portion of the disc of the sun turned intense fiery red. Then when a little more than half the disc had disappeared it changed to yellow. Then when only about 1-6th was left, there were green flashes round the edge of the disc lasting perhaps a second each, and passing round a short arc beginning always at the horizon. Then similar blue flashes appeared. Then when the sun is almost down the whole visible part became greenish with violet flashes. Then the part of the disc visible becomes a line with deep violet at each end, blue next to the violet, and green in the middle parts of the line. Then the violet takes the place of the blue, and blue is in the middle, while deeper, almost ultra violet, colours the ends of the line. Then there is a lingering, rippling flash of deep violet, and the sun is gone.

The flash (as a whole) was much clearer and lasted longer than I have ever seen it before. The telescope used was about 1⅞″ in aperture, with magnifying power 45.

The sea horizon was perfect, and the altitude above sea-level about 55 feet; weather calm, light S.W. wind; filmy clouds in part of the sky, part clear with cloud wisps like nebulæ. Temp. about 52° F.

This description I copy from my notes written on the spot the same evening.

I used no dark glass on the telescope.

I am, Sir,

Yours very truly,

James H. Worthington.

25, Museum Road, Oxford.

To the Editors of "Knowledge & Scientific News."

Sirs,—Referring to Admiral Maclear's letter on this very interesting and beautiful phenomenon, I have been much at sea, and have always taken great interest in, and watched at every opportunity for a sight of it. I have heard all sorts of causes assigned, some rather ludicrous—*e.g.*, that it resulted from the light passing through a film of water as the sun dipped below the horizon. On the whole, I think Admiral Maclear's quotation from Professor Davis' work appears the most probable solution. I have noticed, in a favourable display, that the "flash" changes rapidly from green to blue and violet, which bears out Professor Davis' theory—the red and yellow parts of the spectrum being lost in the general brightness of the sky.

With respect to your editorial note, I would mention that far the finest view of the "green flash" is to be obtained, according to my experience, oft repeated, at sunrise, when there has been no previous "glaring" of the eye to cause the complementary colour-effect. The observation is more uncertain owing to the difficulty of knowing *exactly where* the sun will appear. But a look at the azimuth and amplitude tables enables one to set the sight of the standard compass exactly on the point, as a guide to the eye. And the horizon is more apt to be clear and sharp at sunrise than at sunset, while the brilliance of the flash to the un-tired eye is magnificent. I remember once in the South Atlantic lying in my bunk watching a barque on the horizon, silhouetted black against the eastern sky, and framed in the port-hole, when the sun rose exactly behind it, and the sight was simply too beautiful for words, from the play of bright blue and green light among the tracery of masts and rigging. I have seen the flash *twice* at the same sunset, as we rose and fell on mighty rollers in the Southern Ocean off Cape Leeuwin, of which I sent an account to *Nature*. Some time in the late summer of 1891 I was always careful in watching a likely sunset never to look *directly* at the sun till the last moment, to avoid fatiguing the eye with glare. Also, the best shows were when the sun, on the horizon, was much distorted by refraction.

C. Mostyn.

Tunbridge Wells, February 17, 1906.

Mr. F. W. Levander, Editor of the Journal of the British Astronomical Association, informs us that several communications on the phenomena referred to above are to be found in vols. 7, 8, 10, 11, 12, and 15 of that Journal.

Electric Induction Experiments.

Dear Sir,—My attention has been called to an article which appeared in your journal for August last, on "Some Electrical Influence Experiments," by Mr. Charles E. Benham. The conclusions arrived at in that paper seemed to be so extraordinary, and so opposed to scientific principles, that I have taken the trouble to repeat Mr. Benham's experiments. Preparing three sheets of glass similar to those shown by Mr. Benham in Figs. 1 and 2, page 196, I repeated the experiment as described in your journal, and got the same results as Mr. Benham. But if his interpretation be correct, namely, that the electrification is not due to friction, we would have all the conditions necessary for producing perpetual motion, as the energy necessary for making the successive contacts would be less than might be developed by the electricity. For this reason the presumption was there was an error somewhere.

To find out what was taking place, I connected by means of a fine wire the upper tinfoil F (see Benham's figures) with a gold leaf electroscope, the plates being in position. The strips of tinfoil on the lower plate were now successively earthed, then the upper one was earthed, the lower ones being again earthed in succession, then the top one, and so on a great number of times. The upper plate was now raised, but it showed no signs of electrification; a result one would naturally expect. Instead of now simply earthing the tinfoils on the lower plate by simple contact without friction, they were earthed as described by Mr. Benham, by drawing the finger over the lower surface of the plate so as to earth them in succession as before. When this was done the electroscope showed signs of divergence, which fell on the upper plate being touched, and again rose on stroking the under plate, showing that the earthing of the lower tinfoils by stroking gave rise to a disturbance of the electrification. When this process was repeated a number of times the plates acquired a considerable electric charge. If after the plates have become charged in this manner we simply touch the lower plates in succession, and then the upper one without friction, and do it a number of times, the plates gradually get discharged, as one would expect, the process being a step-down discharge.

With regard to Mr. Benham's statement that the electric charge cannot be due to friction, because after the manipulations described by him the plates are sometimes positive and sometimes negative. On putting this point to the test, I find that shellac varnish on glass when rubbed with the hand is sometimes electrified + and sometimes —, which explains the change of electrification in Mr. Benham's experiment. At first this change in the electrification seemed to be capricious, and it was hard to say what electrification it would take; but at last it came out that the sign of the electrification depended on a number of things. The varnish used in these experiments was the ordinary commercial spirit varnish. The plates were coated by pouring the varnish over them, draining the surplus off, and drying with heat. It was found that one piece of glass so treated became positively electrified when rubbed with the hand, while another piece became negatively electrified, but the electrification of neither of them was constant. In damp air what was previously + became —, whilst the one that was — remained so, but became + when the air was very dry. If the skin of the hand is dry it tends to give +, and if moist —. The tip of the fingers may give +, while the pad formed by closing the thumb on the first finger gives —. A moist, newly washed skin gives —, and a dry one +. If the surface of the varnish be smooth it tends to give +, while if rough to give —. If in place of using the whole varnish, only the clear upper part that forms after the varnish has been standing some time be used, it gives a very fine, smooth surface, which seems to give + in most conditions of humidity of the air, but becomes — if a very little olive oil or other similar substance be on the fingers. From the above, as might be expected, it is no unusual thing for a piece of glass to give electricity of one sign on first rubbing, and of the opposite sign on the second rubbing, changing about in a seemingly capricious manner, but in reality in response to changes in the rubber or surrounding air. Spirit varnish generally contains two gums, and the different proportions of these on the plate seem to determine whether it will tend to give + or — electricity.

J. A.

The Electric Production of Nitrates from the Atmosphere.

Abstract of a Discourse delivered at the Royal Institution on Friday, February 2, 1906, by

Professor Silvanus P. Thompson, D.Sc., F.R.S.

As the demand of the white races for wheat as a food-stuff increases, the acreage devoted to wheat-growing increases, but at a less rapid rate; and being limited by climatic conditions will in a few years, perhaps less than thirty, be entirely taken up. Then, as Sir Wm. Crookes pointed out in his Presidential Address in 1898, there will be a wheat famine, unless the world's yield per acre (at present about 12.7 bushels per acre on the average) can be raised by use of fertilisers. Of such fertilisers the chief is nitrate of soda, exported from the nitre beds in Chili. The demand for this has risen from 1,000,000 tons in 1892 to 1,543,120 tons in 1905; and the supply will at the present rate be exhausted in less than fifty years. Then the only chance of averting starvation lies, as Crookes pointed out, through the laboratory.

In 1781, Cavendish had observed that nitrogen, which exists in illimitable quantities in the air, can be caused to enter into combination with oxygen, and later he showed that nitrous fumes could be produced by passing electric sparks through air. Although this laboratory experiment had undoubtedly pointed the way, though the chemistry of the arc flame had been investigated in 1880 by Dewar, and though Crookes and Lord Rayleigh had both employed electric discharges to cause nitrogen and oxygen to enter into combination, no commercial process had been found practical for the synthesis of nitrates from the air, until recently.

After referring, in passing, to the tentative processes of Bradley and Lovejoy, of Kowalski, of Naville, and to the cyanamide and cyanide processes, attention was directed to the process of Birkeland and Eyde, of Christiania, for the fixation of atmospheric nitrogen, and their synthetic production of nitrates, by use of a special electric furnace. In this furnace an alternating electric arc was produced at between 3,000 and 4,000 volts, but under special conditions which resulted from the researches of Professor Birkeland; the arc being formed between the poles of a large electro-magnet, which forced it to take the form of a roaring disc of flame. Such a disc of flame was shown in the lecture theatre by a model apparatus sent from Christiania. In the furnaces, as used in Norway, the disc of flame was four or five feet in diameter, and was enclosed in a metal envelope lined with firebrick. Through this furnace air was blown, and emerged charged with nitric oxide fumes. These fumes were collected, allowed time further to oxidise, then absorbed in water-towers or in quicklime—nitric acid and nitrate of lime being the products. The research station near Arendal was described; also the factory at Notodden, in the Hitterdal, where electric power to the extent of 1,500 kilowatts was already taken from the Tinnfoss waterfall for the production of nitrate of lime. This product in several forms, including a basic nitrate, was known as Norwegian saltpetre. Experiment had shown that it was equally good as a fertiliser with Chili saltpetre; and the lime in it was of special advantage for certain soils. The yield of product in these furnaces was most satisfactory, and the factory at Notodden—which had been in commercial operation since the spring of 1905—was about to be enlarged; the neighbouring waterfall of Svaelgfos being now in course of utilisation would furnish 23,000 horse-power. The Norwegian company had further projects in hand for the utilisation of three other waterfalls, including the Rjukanfos, the most considerable fall in Telemarken, which would yield over 200,000 horse-power. According to the statement of Professor Otto Witt, the yield of the Birkeland-Eyde furnaces was over 500 kilogrammes of nitric acid per year for every kilowatt of power. The conditions in Norway were exceptionally good for the furnishing of power at exceedingly low rates. Hence the new product could compete with Chili saltpetre on the market, and would become every year more valuable as the demand for nitrates increased, and the natural supplies became exhausted.

What is at the Centre of the Earth?

By H. de St. Dalmas.

The mystery of this question is assigned as one reason for its investigation. It is, indeed, remarkable that less should be known about the earth's composition, even at the depth of a few miles, than is known of the composition of stars millions of miles away.

In "Knowledge" for January doubt is cast on the generally accepted theory of a regular and sustained increase of heat as the earth's crust is penetrated. The data are not sufficient to establish this theory. The increase of heat in deep mines and borings has been attributed to the central heat of a gradually cooling planet. How can we know that this is the true cause of the heat at only a mile or two from the earth's surface, seeing there is no proof that the fiery heat extends to the earth's centre?

Reasoning on the effects of pressure at various depths, Mr. Beresford Ingram suggests that the earth may consist of "three concentric rings," having a solid nucleus from 3,000 to 7,000 miles in diameter, next a liquid substratum, and finally the earth's crust, variously estimated at from 70 miles to 2,000 miles in thickness.

Dr. Edmund Halley propounded a similar theory of the earth's composition before the Royal Society in 1694. The mysteries of terrestrial magnetism seemed to point to such an arrangement to account for the uniform slow revolution of the magnetic pole round the pole of the earth. The nucleus (or *Terrella*) imagined by Halley, though concentric with the main body of the earth, he maintained rotated on a different axis, the axis of the nucleus being indicated by the magnetic poles. Halley considered that the axis of the nucleus was originally that of the entire earth, and that a change of axis had taken place in relation to the outer globe, this being the physical cause of the deluge, as it would necessarily bring the ocean waters and Arctic ice over mountains and continents.

Halley maintained this belief more than thirty years till his death. The late Sir Edward Sabine, speaking from the Presidential chair of the Royal Society in 1864, said that "the objections that might have impeded the reception of such an hypothesis . . . are no longer tenable."

The late astronomer royal, Sir George Airy, expressed the opinion "that the general cause of the earth's magnetism still remains one of the mysteries of cosmical physics." The distinguished Lord Kelvin has expressed himself similarly only a few years ago. So that we are now no further advanced in actual knowledge of the earth's interior and of terrestrial magnetism, than when Halley maintained more than 200 years ago that "thus and not otherwise" could the facts be explained.

Halley's theory of the earth has been popularised by the late Rev. W. B. Galloway, M.A., in "Science and Geology in Relation to the Universal Deluge" and "The Testimony of Science to the Deluge." Mr. Galloway shows that the specific gravity of the earth being about $5\frac{1}{2}$ times that of water, whilst the rocks at the earth's surface do not average more than $2\frac{1}{2}$, it follows that the heaviest substances, such as gold and platinum, should be at the centre, and that mercury or quicksilver, in harmony with its specific gravity, might form the liquid substratum between the two differently rotating globes. The arguments—astronomical, geological, climatic, and historic—in support of Halley's and Galloway's theory of the earth are well worthy of examination.

Whilst astronomers and geologists cannot tell if the earth has a rigid core or a molten interior, the hypothesis of "three concentric rings" should not be regarded as untenable, *i.e.*, an inner and an outer globe with a fluid substratum, such as mercury, petroleum, or molten lava (all of which have been suggested) interposed between the *Terrella* and the outer globe. In such case the heat, which is found to increase in descending below the earth's surface, might be caused by the friction of two differently rotating bodies, and not by imaginary fires at the centre of the earth

Rare Living Animals in London.

By P. L. SCLATER, DR.SC., F.R.S.

VI.—Forster's Lung-Fish (*Ceratodus forsteri*).

A "QUEER FISH" is a proverbial expression, and is certainly very applicable to the fish now figured from one of two specimens received by the Zoological Society in 1898, and still living in one of the large tanks in the reptile house.

For many years there had been known from the Triassic strata of various parts of Europe, certain fossil teeth of fishes of a remarkable character. From their fancied resemblance to deer-antlers these teeth, which were the only part of the fish known, were named *Ceratodus*, or "Horn-tooth." Similar teeth were subsequently obtained from the secondary strata of India, and from the Jurassic rocks of Colorado and Montana, in North America, but little, if any, additional information about them was procured. Suddenly, in 1870, the extraordinary discovery was made that this "queer fish," or, at any rate, one with similar teeth, was actually still existing in certain rivers of Queensland, where it is known to the natives as the "Barramondi."

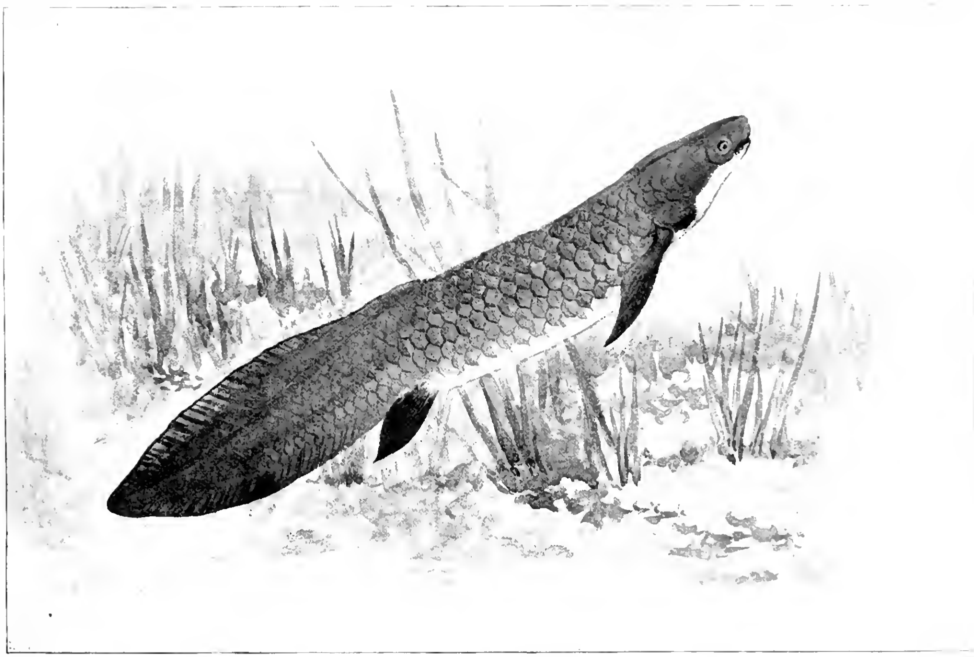
The naturalist who first made known this remarkable fact, was the late Gerard Krefft, a corresponding member of the Zoological Society of London, and for many years curator and secretary of the Australian Museum, Sydney. Krefft had obtained his specimens from Mr. William Forster, M.C.A., and published a description of them in the "Proceedings" of the Zoological Society, under the name *Cer*[illegible] (P. Z. S., 1870, p. 221). He referred them, no doubt correctly, to the genus *Ceratodus*, by which name Agassiz had designated similar teeth in his "Recherches sur les Poissons Fossiles."

The Barramondi is, in these days, found in a state of nature, only in two little rivers of Queensland, the "Burnett" and the "Mary," though its fossil remains prove that it formerly extended over a far larger portion of Australia. The best account of its life and habits will be found in Dr. Richard Semon's most interesting work "Im Australischen Busch," of which an English translation was published in London in 1899. The same author has likewise devoted a whole volume of his "Zoologische Forschungsreisen," to a monograph of this extraordinary fish.

The first, and, as I believe, the only specimens of the *Ceratodus* ever brought to Europe alive, were received at the Zoological Society's Gardens in June, 1898. Four of these fishes, captured in the River Mary, were safely conveyed to England by Mr. D. O'Connor. Two of them were purchased by the Zoological Society, for the sum of £45, and, as already stated, are still living in the Gardens much increased in size and condition. The two others were taken by Mr. O'Connor to Paris and sold, I believe, to the Jardin des Plantes. I do not know whether they are still alive or not.

Mr. O'Connor gave the Zoological Society the following account of the capture of his specimens of *Ceratodus*:

"Some ten or twelve years ago, the late Sir Ferdinand von Mueller and other scientific men of



Forster's Lung-Fish (*Ceratodus forsteri*).

Australia, were apprehensive that *Ceratodus* was likely to become extinct, mainly owing to their being largely destroyed by settlers and miners, who highly esteemed them as an article of diet. They were mostly killed by dynamite, a very destructive agent. The curious fact was also noted that no small specimens of *Ceratodus* were ever seen; two of those brought to your Gardens are the smallest I ever met with, excepting a stuffed specimen, which measured 21 inches. The Royal Society of Queensland, with a view to the preservation of *Ceratodus*, resolved to remove specimens to new habitats, and I was asked to undertake the work. My first month's experience was very discouraging, resulting in only one live fish, but better success followed, and in less than six months, sixty-nine examples were transported to six new localities. This success encouraged me to try the experiment of taking a few to England. I had some caught and kept in captivity a few weeks, and fed mainly on prawns. They were shipped in the *Duke of Devonshire*, on the 15th of April, and arrived in London on the 12th of June, after a passage of eight weeks. My success was mainly owing to the exceptionally fine weather enjoyed throughout the voyage, there not being an hour rough between Brisbane and the Thames."

Ceratodus belongs to the "Dipnoan" (or double-breathing) Order of Fishes—so called because they breathe not only by their gills, as ordinary fishes, but also by their lungs, like the higher vertebrates.

Our picture (page 379), represents one of these fishes coming up to the surface of the water, as they frequently do, to imbibe a little more oxygen.

Besides *Ceratodus*, there are two other fishes belonging to the formerly widely-spread Order of Dipnoans, the *Lepidosiren* of South America, and the *Protopterus* of Africa. These three forms are the sole survivors of this great group, which in former ages was extensively distributed over the earth's surface.

Star Map No. 5.

THIS map shows Orion in the right hand top corner, Sirius towards the centre, and the "False Cross" at the bottom. Several fine stars are included in this region.

β Orionis (Rigel), magnitude 0·3.

Nebula Orion M 42 (V h. 30 m. 5° 30′ S.), the greatest nebula in the heavens. Although only the nucleus is readily visible, the nebula extends for vast distances all around. Its spectrum shows it to be gaseous.

θ Orionis (V h. 22 m. 5° 28′ S.). A multiple star in the brightest part of the above nebula. Four stars of 6, 7, 7½, and 8 magnitude form a trapezium.

σ Orionis (V h. 34 m. 2° 39′ S.) "the hilt of the sword," is a multiple star, consisting of 2 sets of treble stars, as well as others.

α Argus (Canopus) (VI h. 21 m. 52° 38′ S.). The second brightest star; magnitude – 1·0.

α Canis Majoris (Sirius) (VI h. 41 m. 16° 35′ S.), magnitude. – 1·4. The brightest star in the heavens. It has a small companion, magnitude ·9, at a distance of 6″·3. The light is calculated to be 30 times as bright as that of the Sun, while the mass of the star is only 2½ times as great. Sirius is one of the nearest of the stars, the distance being 8·6 light-years. Its parallax is ·38.

α Canis Minoris (Procyon) (VII h. 34 m. 5° 28′ N.) is another near and bright star. Its parallax is ·3: distance in light-years, 10·9. Magnitude, 0·5. It is accompanied by a large and feebly luminous companion, giving out only about one-thousandth the amount of the light of the Sun.

Qualitative Analysis Without the Use of Hydrogen Sulphide.

By H. J. H. FENTON.

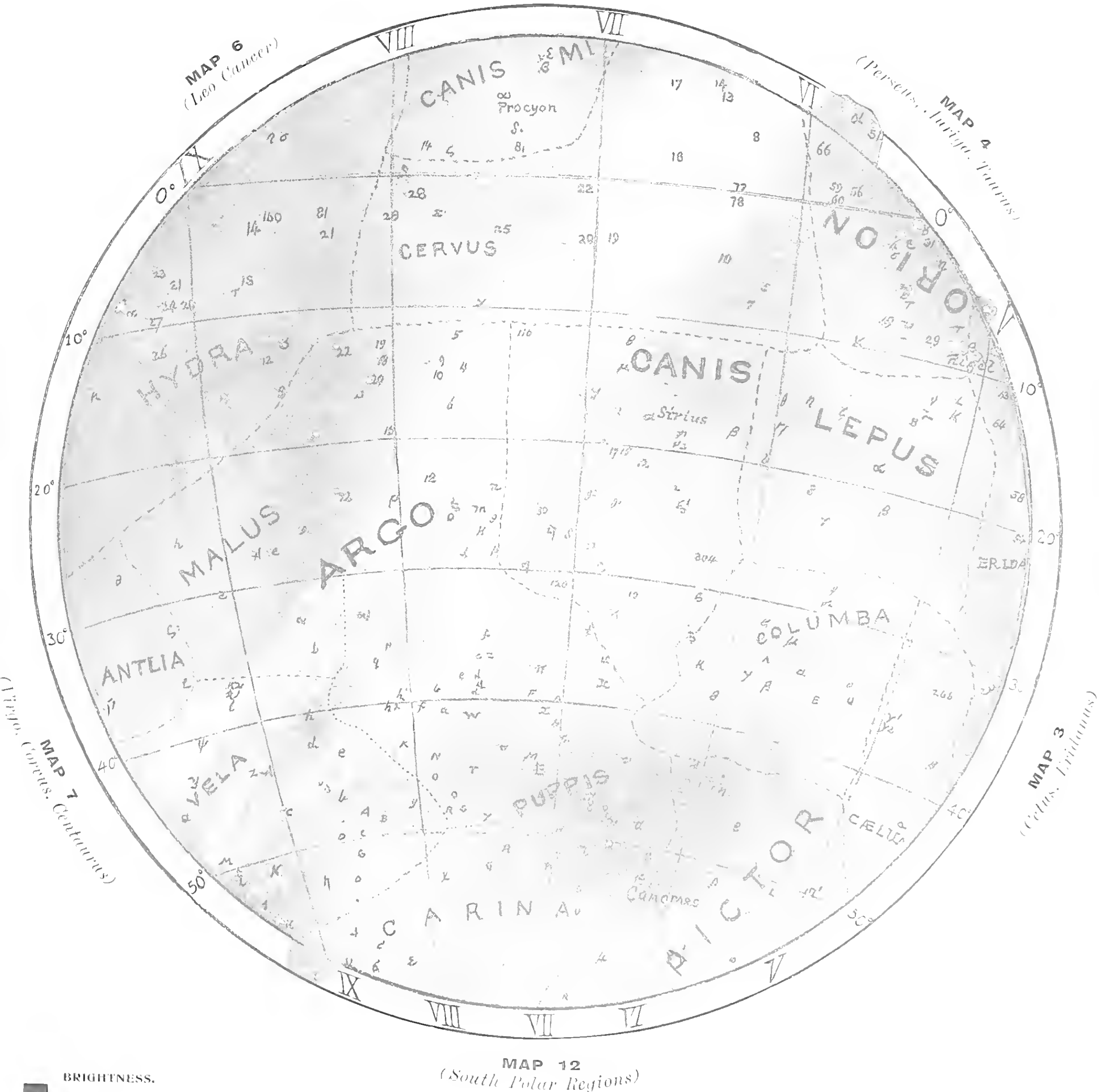
THE separation of metals belonging to the "second group" by means of hydrogen sulphide, in presence of dilute hydrochloric acid, has hitherto been universally regarded as one of the principal and essential stages in systematic qualitative analysis. This method—originally devised by Bergmann and improved later by Fresenius—may, of course, yield excellent results if due precautions are taken; yet from a theoretical standpoint it is anything but perfect, since the conditions (concentration, degree of "acidity," temperature, etc.), which are favourable to the most complete precipitation, vary considerably with the different sulphides.

On the practical side the objections are more serious, especially in view of the highly offensive and even poisonous nature of the gas; there are difficulties also, especially in small laboratories, in arranging for a constant and regular supply, and considerable waste invariably results owing to the excessive rate at which the gas is passed and the inveterate tendency of students to "leave the tap turned on."

In consequence of these objections many attempts have from time to time been made to devise methods of separation which are independent of the use of hydrogen sulphide. Klein, for example (1887), proposed the use of ammonium dithiocarbamate, Vogtherr (1898), of ammonium dithiocarbonate; and Schiff and Tarugi (1894), of thioacetic acid or its salts. Rawitsch (1899) avoided the use of hydrogen sulphide itself by digesting the mixture to be analysed with excess of yellow ammonium sulphide, and subsequently treating both residue and solution with dilute hydrochloric acid. None of these suggested modifications, all of which, it will be observed, make use of sulphur compounds, have received much support from chemists; either the preparation of the reagent in question presents difficulties or else the method of separating the resulting compounds is found to be imperfect.

A paper has recently been published by Ebler [Zeitschrift fur Anorganische Chemie, 1905 (48) 61], in which he proposes to get over the above-mentioned difficulties by entirely different methods and by employment, in some cases, of reagents which, although comparatively new, can now be easily obtained as commercial articles. Possibly amongst our readers there may be some who are interested in analytical chemistry, but who have not the opportunity of studying the recent literature on the subject, and to these a brief sketch of the paper may be of advantage.

In constructing this new scheme of analysis the author takes advantage especially of the tendency which certain metals have to form complex cations, of various degrees of stability, with ammonia, and he employs as reagents, in addition to those in common use, such compounds as hydroxylamine, hydrazine, and potassium percarbonate.



BRIGHTNESS.

- 1st Mag.
- 2nd ,,
- 3rd ,,
- 4th ,,
- 5th ,,
- 6th ,,
- Variable
- Nebula.

MAP No. 5.

Argo, Canis Major.

It is necessary in the first place to remove tin and antimony, since they are only partially precipitated by the ammoniacal reagents employed; arsenic and phosphoric acids have also to be got rid of, since they would cause complication in precipitating the heavy metals, magnesium, &c. The solution to be examined is, therefore, evaporated repeatedly with concentrated nitric acid; this converts tin and antimony into the insoluble metastannic and antimonic acids, in which form they are easily removed. Phosphoric acid is eliminated by the well-known tin method, and arsenic, if present, is either vaporised away as methyl arsenate (by distilling with methyl alcohol and hydrochloric acid), or is rendered "harmless" by reduction to the arsenious state. In order to bring about the latter change the author employs a mixture of fuming hydriodic acid and hydrazine chloride; the reduction by hydriodic acid alone is limited and reversible, but the hydrazine (by reconverting I into HI) renders it complete.

Silver is separated in the usual manner by hydrochloric acid and the solution (2), which may now contain the remaining (common) metals—Fe, Pb, Bi, Al, Cr, Hg, Cu, Mn, Zn, Cd, Ni, Co, (As^{III}), Mg, Ba, Sr, Ca, K and Na—is mixed with hydroxylamine hydrochloride and excess of ammonia; it is then heated in a water-bath until the odour of ammonia nearly disappears. In this way, aluminium, iron, chromium, bismuth, and lead are precipitated as hydroxides, and mercury as metal. [The addition of the hydroxylamine in this case not only ensures the complete separation of iron, whether it be present as ferrous or ferric, but it also entirely prevents the separation of manganese, which would otherwise partially fall out as brown hydrated oxide when the ammoniacal solution is exposed to air. The copper is reduced to the cuprous state, and mercury to metal; these reducing effects will also be brought about by hydrazine if the latter has been employed for the reduction of arsenic acid as mentioned above.]

The precipitate (3) is dissolved in concentrated nitric acid and mixed with excess of ammonia; in this way the mercury is retained in solution as a complex salt, mercuri-ammonium nitrate, and the other metals (Fe, Pb, Bi, Al, Cr), are again precipitated. The latter are separated and identified in the usual manner; the bismuth as oxychloride, lead as sulphate, iron and aluminium as hydroxides, and chromium as chromate. For the oxidation of chromium in alkaline solution the author employs potassium percarbonate, which not only keeps better than hydrogen dioxide, but is also more economical.

From the ammonia-hydroxylamine filtrate after acidification (3) the copper, which now exists as complex cupro-ammonium salt, is precipitated as sulphocyanate or as iodide (if the arsenic acid reduction has been gone through the cuprous iodide will, of course, separate on merely acidifying this solution); ammonia and ammonium sulphide are then added, which precipitates manganese, zinc, cadmium, nickel, and cobalt as sulphides. These are dissolved in aqua regia, the excess of acid removed, and the solution mixed with soda and hydrogen dioxide, or, better, potassium percarbonate. Zinc now remains in solution as zincate, and the remainder are precipitated as $MnO(OH)_2$, $Co(OH)_3$, $Ni(OH)_3$, or $Ni(OH)_2$, and $Cd(OH)_2$. Percarbonate is here advantageous, since the nickel comes down as dark brown nickelic hydroxide, which is easily filtered and washed. The further separation is conducted on the usual lines.

The filtrate (10) from the ammonium sulphide precipitate contains arsenic as sulpho-salt (unless arsenic was initially removed), and the other metals—magnesium, barium, strontium, calcium, potassium, and sodium as chlorides, &c.; on acidification with hydrochloric acid the arsenic separates as sulphide, and the solution is examined for the remaining metals in the usual manner after destroying the excess of ammonium salts.

A glance at the subjoined table, which is an abbreviated form of the one given by the author, may serve to indicate the essential stages in this new scheme of separation.

Evaporation with concentrated [illegible]

Residue (1): **Sn. Sb.**

Solution (1) Fe. Pb. Bi. Al. Cr. Hg. [illegible] Ni. Co. As. Mg. Ba. Sr. Ca. K. Na. Removal of phosphoric acid. [illegible] of arsenic acid. Addition of hydrochloric acid.

Precipitate (2): **Ag.**

Solution (2). Addition of hydroxylamine hydrochloride and ammonia.

Precipitate (3). Fe. Pb Bi. Al. Cr. Hg. Dissolution in excess of nitric acid and precipitation with ammonia.

- Precipitate (4). Fe. Pb. Bi. Al. Cr. Dissolution in hydrochloric acid and dilution with water.
  - Precipitate (5). **Bi.**
  - Solution (5). Pb. Fe. Al. Cr. Addition of dilute sulphuric acid.
    - Precipitate (6). **Pb.**
    - Solution (6). Fe. Cr. Al. Addition of Soda and potassium percarbonate (or H_2O_2)
      - Precipitate (7). **Fe.**
      - Solution (7). Cr. Al. Addition of Ammonium chloride.
        - Precipitate (8). **Al.**
        - Solution (8) **Cr.**
- Solution (4). **Hg.**

Solution (3). Cu. Mn. Zn. Cd. Ni. Co. (As.) Mg. Ba. Sr. Ca. K. Na. Acidification with dilute hydrochloric acid and addition of ammonium sulphocyanate or iodide.

- Precipitate (9) **Cu.**
- Solution (9). Addition of ammonia and ammonium sulphide.
  - Precipitate (10). Mn. Zn. Cd. Ni. Co. Dissolution in aqua regia and addition of soda and potassium per-carbonate (or H_2O_2)
    - Solution (11) **Zn.**
    - Precipitate (11). Dissolution in hydrochloric acid and precipitation with ammonia and hydrogen dioxide.
      - Precipitate (12). **Mn.**
      - Solution (12). Cd. Ni. Co. Evaporated with [illegible] destroy ammonium [illegible] solution in hydrochloric acid [illegible]
        - Precipitate (13). **Cd.**
        - Solution (13). Ni. Co. [illegible] precipitation with [illegible] water as usual
          - Precipitate (14). **Ni.**
          - Solution (14) **Co.**
  - Solution (10). (As). Mg. Ba. Sr. Ca. K. Na. Acidification with dilute hydrochloric acid
    - Precipitate (15) **As.**
    - Solution. Mg. Ba. Sr. Ca. K. Na. Separated by the ordinary methods.

NOTE.—Residue (1) may also contain Sulphates of Pb. Ba. Sr. Ca. It is examined in the usual manner.

THE editors of the *Geological Magazine* (Dr. Henry Woodward, F.R.S., and Dr. H. B. Woodward, F.R.S.) held a reception on Thursday, February 8, to commemorate the publication of the 500th number of the magazine. The rooms at No. 5, Johnson Street, Notting Hill Gate, W., were well filled, and many ladies and distinguished men of science gladly responded to the invitation. Excellent music, vocal and instrumental, was provided, and geological photographs and drawings were exhibited. We trust the *Geological Magazine* may long continue its most useful work.

The Eolithic Controversy.

By J. Russell Larkby.

The recent renewal of the controversy on the nature of Eoliths (*Man*: Anthropological Inst., Oct., Nov., and Dec., 1905) has had the result of awakening further interest in the question of the authenticity of these forms as illustrating a pre-Palæolithic period of man's progress. As suggested in my note in "Knowledge" for October, 1905, p. 252, it is necessary for the objectors to the artificial origin of these forms to show that the mechanical process of Mantes in any way resembles the natural method by which the plateau or any other gravels were laid down.

On December 19, 1905, Mr. S. Hazzledine Warren, F.G.S., read before the Anthropological Institute a paper on this question, in which he attempted to show the purely natural origin of these forms. In illustration of his contention Mr. Warren made several pseudo-Eoliths, which were handed round for the inspection of his audience. The mechanical process in this case took the form of a screw press, in the lower jaw of which was a small circular pit; two stones were placed in this receptacle, and on pressure being applied, the flints were fractured in a way which certainly, to some extent, resembled Eolithic implements. Whilst congratulating Mr. Warren on the ingenuity thus displayed in support of his contention, it is impossible to give assent or support to his deductions. I should characterise this process as an artificial method of the most pronounced type; it rests with its originator to prove that any legitimate comparison can be drawn between the screw press and natural deposition. Mr. Warren eliminated two most important factors in his experiment; in the first place, the presence of water under natural conditions must very materially reduce the intensity of any blows received by the stones when undergoing free rolling in a river bed; secondly, the hard, rigid bed of the screw press has no similarity to the soft and muddy floor of a river channel, hence the blows received by flints in the process of rolling would again undergo a considerable diminution. I would again emphasize the fact that in the plateau gravels there are forms which are not only definitely chipped, but are almost wholly unabraded by transport; others, however, show the work obscured by subsequent rolling, and to some of these highly-worn examples exception might well be taken if they were not accompanied by the unworn forms. It may, however, be objected that the very presence of the chipped edges is indicative of natural action, and this obviates the necessity of supposing man's presence here during the deposition of this drift. To this it may be answered that those flints with slightly abraded edges bear very few insipient cones of percussion on their flatter surfaces; therefore, if the chipping is purely natural, the process of rolling was confined entirely to certain areas of the stones. This hypothesis will not commend itself to students of the question save as a *reductio ad absurdum* of the natural origin theory, and yet it is the conclusion to which our opponents are forced if they persist in attributing these forms to some agent other than an intelligent being. Mr. Warren's contention seems to be that as the results of certain mechanical methods of the present day closely simulate man's work in the past, *ipso facto*, man has never produced them at all; but to produce such forms by an essentially artificial method, and then to assert that in the past they could only be the outcome of natural action seems to me to be illogical. Mr. Warren's answer to the claim that Eoliths are shaped according to definite types, is that the shape is governed by the existence of lines of weakness; therefore, the matter of definite type is simply the natural result and proof of such lines of weakness. The argument is pleasantly attractive from a purely theoretical point of view, but it is essentially a case of assertion arising from assumption. It is necessary to prove the existence of these lines of weakness where they would be least expected, *i.e.*, the thickest parts of the flints, for some Eoliths in my collection are as well chipped at the base as at the thin edge.

To the "creep" of frozen and partially frozen soils and gravels Mr. Warren would assign some types of Eoliths; but here, again, is very debatable ground. My own observations in the area of the Darent and Cray lead me to believe that in this instance very little post-deposition movement has taken place; as the only site at which there is clear evidence of frozen conditions is a small plateau carrying a high level Darent gravel, the "creep" must have been of an insignificant nature —hopelessly insufficient, it may be suggested, to shape and chip the definitely-formed and striated Eoliths found there. To those who have devoted their time to practical investigation in the field and to careful classification at home, it may seem inconceivable that the definite and classifiable types of plateau flints are merely the result of fortuitous batterings; save on the theory of intelligent design, it is difficult to believe that certain forms would be repeated over and over again and attained by a remarkable similarity in the type of work and the angle of chipping.

All students of this interesting question are indebted to Mr. Warren for his careful paper, and if it fails to obtain the elimination of Eoliths from the field of science, it will at least show the crying need for greater care in the admission of indefinite evidence in support of our claim. There can be little doubt that even in England flints have been admitted as evidence which should have been left in the field or consigned to the heap of rejected forms in the garden. When, however, it is said that in the gravels of St. Prest 80 per cent. of the flints are considered as either "utilised or retouched,"* it is impossible to refrain from raising the cry of "Siste, viator."

To Make Iron Grow.

To the Editors of "Knowledge & Scientific News."

Sirs,—In your January number, page 330, you have a short notice under the above heading, showing that iron by repeated heating to a critical temperature and cooling can be made to expand in cubical dimension to 40 per cent. of its original size. No theory except the globular molecular theory can account for this.

The globular molecular theory is this. That the molecule in gases and liquids is a hollow globe, and in solids a variously shaped hollow mass, all with their inner spaces

* Dr. Hugo Obermaier, in *Man*, 1905, Art. 102.

occupied with æther; that the molecules are in touch with one another and occupy all the space that gravitation (pressure) permits; that the only other force acting on the molecules is that form of gravitation named cohesion; that the cohesion that acts on a molecule by contact with its neighbours is greater, because of the interior space, than the cohesion tending to solidify the molecule; that the molecule consists of superposed globular shells of the elements that compose it; that that expands the molecule by entering it as vibrating æther which expends its vibrations in the work of expansion and thereafter remains as what is called latent heat; that when the contained æther leaves the molecule by the need to level, or, as it may be called, equalise itself, it is thrown into vibration and appears as radiant heat.

The heating of the iron makes its crystalline molecules expand and approach the globular shape. There are then small spaces among the molecules that there need not be in the cold mass if the crystalline shapes are perfectly arranged together. The æther in these small interspaces in the hot mass is in violent vibration, and this motion, in addition to the production of radiant heat and light, is some of it expended in displacing the crystalline molecules, with the result that the mass is increased in dimension.

No theory that includes flying atoms can explain this expansion of the iron.

W. F. BADGLEY.

February 4, 1906.

Answers to Correspondents.

Mock Suns.—W. H. C. sends an account with sketch from Canada of "Sun Dogs," and asks the cause of the phenomenon.

These "mock suns" have for long been well known. Most books on meteorology refer to them (*e.g.*, Hartwig's *Aerial World*). Similar phenomena have been described in many accounts of Arctic or Antarctic regions (Capt. Scott in the *Voyage of the "Discovery"* gives a coloured illustration of one). The effect is caused by the polarisation of the light on striking the small crystals of ice suspended in the air.

The Star towards which the Earth is Travelling.—A. F. M. asks whether this star is visible to the naked eye, and what size it is as compared to Sirius. The whole solar system is moving in the direction of Vega, a star of the 1st magnitude. This is proved by the fact that the stars in this neighbourhood are gradually opening outwards, while those in opposite direction are closing together. Vega appears smaller than Sirius, the relative magnitudes being 0.1 and 1.4 respectively.

Occultation of Star by the Moon.—T. A. Lowndes writes describing accurately the "strange sight" he saw on February 3 at 20 minutes past 5. A small star was close to the moon and appeared to be *in front* of the dark part of it. It disappeared at 27 minutes past 5. Under the "Face of the Sky" in our February number one may see that on February 3 at 5.23 the first magnitude star Aldebaran was in occultation with the moon. The bright star close to the edge of the dark portion of the moon would be very liable to have the appearance of being in front of it. Several smaller occultations occur this month (*vide* "Face of the Sky").

Frogs found in Rocks.—E. Braddock asks for information respecting the alleged finding of live frogs in rocks. Mr. Frank Buckland went into this subject many years ago, and the conclusion that he came to was that in every well authenticated case it was found that some crack or other means existed by which the frog could obtain air and probably insect food. Though such reptiles undoubtedly live to a great age, it seems probable that in these cases the frog or tadpole may have become caught in some crevice, and bit by bit have worn a larger hole for itself as it grew.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Colour Sensations.—There are various opinions as to the principles upon which colour photography should be based. Some consider that four colours are necessary, others that three colours are sufficient, and that there is considerable scope for choice in the selection of the three, but there can be no doubt that the present position of colour photography, if not its very existence, is largely due to endeavours to record separately the colours that correspond to the three sensations, so that these may be stimulated by the various parts of the finished photograph in the same proportions as by the corresponding parts of the original. From this point of view the colour sensations are of prime importance to the photographer.

Since 1899 Sir William Abney has been engaged in revising the details that he then published, expressing the three sensations in terms of luminosity, and he has lately published the results of his work. He has obtained results that were impossible before, by a modification of his well-known colour-patch apparatus. Light from an arc lamp is passed through a train of two prisms, and then by means of a semi-silvered mirror a part is diverted, and so two spectra are formed, each of which is received on a plate with three adjustable slits in it and a lens beyond for combining the transmitted lights to form a patch. Thus on the screen two adjacent adjustable colour patches are formed, and also a patch of white light obtained by a mirror by reflection from the first face of the first prism. The luminosities of the patches of light are regulated for photometric purposes by revolving sectors as usual.

A re-determination of the sensation curves by means of this more efficient apparatus, in conjunction with other experiments, leads to the conclusion that there is no fourth sensation excited by violet light, as has been suggested by Burch. The revised curves show only slight alterations from those previously given, and this chiefly in the green, where the three sensations overlap and give an admixture of white with the predominant colour. The curve of this "inherent white" shows no sudden rise in any colour as was represented in the curves previously given. The amount of blue sensation in the yellow and green of the spectrum has also been corrected. Full tables and curves, and a description of their applications in three-colour photography, are given in the Philosophical Transactions of the Royal Society (series A, vol. 205, pp. 333-355). The paper can be obtained separately from Messrs. Dulau, of Soho Square, for one shilling.

The Bleaching-Out Three-Colour Process.—The principle involved in this method of reproducing colour by exposure to light of the prepared material under the original is of a very simple character. The three necessary colours are contained in the sensitive film, and on exposure the colouring matter that absorbs light is bleached while that that transmits the light remains, or, at least, remains longer than the others. Red light, for example, or the light that passes through the red parts of the original, being transmitted by the red dye has very little effect upon it, but it is absorbed by the blue and yellow dyes bleaching them, and leaving a red colour in the print that corresponds with the red of the original. The difficulties of working out such a method are such that they might well be regarded as insurmountable. The three dyes must not only be of the correct tints, but they must be fugitive enough to be bleached by an exposure to light of a reasonable duration, and, after the print is made, they must be permanent enough to be but little affected by ordinary light. It is sought to secure these opposing qualities by adding materials that induce a temporary sensitiveness, and removing them when the print is made.

Jan Szczepanik has overcome these difficulties so far that the firm of J. H. Smith and Co., of Zurich, are preparing to issue the sensitive material commercially. At the exhibition of colour photographs arranged by the editors of the *British Journal of Photography* at their offices, and which is just about to close, there are a few very striking examples of this process, copies of "lithophanes," that is, the coloured material sometimes used for window decoration. The colours in the copies are very clean and bright. Of course, the large flat patches of crude bright colours in the originals are not so severe a test as more delicate neutral tints, and as the originals are not exhibited it is impossible to tell whether the colours of it are fairly matched in the copies, but it is quite evident that bold colours of very various kinds have been obtained.

Mr. Coburn's Work.—There is an exhibition of the "Work of Alvin Langdon Coburn" at the house of the Royal Photographic Society in Russell Square, to which anyone is welcome, until the end of March, on presentation of his card. The exhibits are advisedly not called photographs, for we learn from Mr. Bernard Shaw in his preface to the catalogue that Mr. Coburn is very mixed in his methods, making gum prints, for example, on the top of platinum prints. When Mr. Shaw tells us that Mr. Coburn has "condescended to oil painting as a subsidiary study," we are led to expect excellent work in spite of Mr. Coburn's lack of experience, for he is a young man of only three-and-twenty. The series of some forty portraits is distinctly interesting. They are done in an unconventional style, and although a few of them appear to show a desire to be eccentric, some of them are very fine indeed, and well repay the trouble of a visit to see them. Of the eighty other specimens, Mr. Bernard Shaw appears to consider it necessary to make a sort of apology, for he tells us that Mr. Coburn's "impulse is always to convey a mood, and not to convey local information," but the author himself entitles the most of them by the names of places, streets, bridges, and so on. For my part I cannot imagine them "conveying moods" of a pleasant or satisfactory kind to anyone; their detailless flat patches, extreme want of definition, and the absence of a sense of due proportion, are distinctly unpleasing, and the representations of places that I know are useless as reminders. If these pictures were not put forward as serious work—and I suppose that they are meant to be taken seriously—I should have thought that they were a beginner's attempts, with here and there a promise of better things in the future if the maker of them considered it worth while to persevere. It is difficult to believe that these "works" and the portraits in the other room are by the same author.

Received.—The Thornton-Pickard Catalogue for 1906 is to hand, and besides the well-known specialities of the firm, it includes a new pattern of the "Royal" shutter, that is, the roller-blind shutter with the mechanism inside the case, and a low-priced outfit called the "Imperial Perfecta."

REVIEWS OF BOOKS.

Our Stellar Universe. Stereoscopic Star-Charts and Spectroscopic Key Maps. Thomas Edward Heath. (King, Sell and Olding, Ltd.). (26+vi. with 26 plates and 26 stereograms.) 10s. net.—Changing his view-point, Mr. Heath, instead of imagining himself at a distance of many light years from the Solar system, now endeavours to give a 3-dimension idea of the relative distribution of stars as seen from the earth, replacing the celestial sphere for this purpose by 26 regions, which for the purpose of the key maps are represented by tangent planes, one at each pole, eight round the equator, and eight each at latitude 45° north and south respectively. The corresponding stereograms by the introduction of measured discs, and an allowance for parallax 19,000 times greater than the truth, do represent a system hanging in three dimensions, and the effect is certainly much improved by the piercing of the stereograms to give the stellar appearance not evident on the prints. A special set on thick card is issued at 5s. (or 2s. 6d. to purchasers of the book). Authorities are given for the values used for parallax of the better determined stars: for others an average parallax according to spectrum-type is used, which, although it improves the appearance of the stereograms by admitting a larger number of stars, is open to criticism on account of the arbitrary assumption involved. This, however, is of no great consequence, as the scientific value of the stereograms is of much less importance than their popular interest. The spectroscopic key maps give full details as to the name, magnitude, spectrum-type, and parallax of the principal stars, and are meant to enable the purchaser to identify the objects represented in the stereograms, which look far less familiar than the actual stars in the sky. It is unfortunate that the endeavour to cultivate a sense of proportion, which is so often lacking nowadays, should be compelled to start with an exaggeration of such a magnitude as 1 to 19,000. But the fault is not with the author, whose device is to be commended for its boldness. It is possible that we shall see this principle of exaggeration carried even further, on the ground that the relative proportions are strictly preserved as under a high-power microscope, but the work of Mr. Heath goes as far as appears advisable in that direction. It should be remembered that magnifying the parallax 19,000 times does not mean observing with eyes 19,000 times the normal distance apart, but with eyes whose distance apart is 19,000 times the diameter of the earth's orbit, or about 3½ billions of miles.

The Reconstruction of Belief, by W. H. Mallock (Chapman and Hall), price 12s. net.

This great work, by the author of "Is Life Worth Living," is somewhat disappointing. The enquirer after religious truth, the agnostic requiring enlightenment, the Catholic anxious for confirmation of his early teachings, all are likely to close the book with the feeling that they are not much the wiser than when they opened it. Yet it is all good reading and sensibly written, and if, after a study of it, we are not convinced as to the exact standing and meaning of modern religion, at all events our minds may be opened and our thoughts concentrated on many points well worth considering.

The author points out that at the root of Christianity are three doctrines, namely, that the universe is over-ruled by some supreme intelligence, who has for his special object the highest good of man; that each man is a self-directing personality, answerable as such to the supreme intelligence for his conduct; and that his life here derives an infinite importance from the fact that it will be prolonged and completed for better or for worse hereafter. He then adds that even those who are satisfied to let these doctrines go, are conscious of some sort of loss, and desire to find a substitute for them; whilst others are looking about for some means of defending them, which may justify them in retaining their faith. It is to this latter class that the present volume is addressed, and though they may derive some comfort and extract many useful ideas, we think it cannot be said that all doubts such as linger in many minds to-day will be eradicated.

The Religion of Woman, by Joseph McCabe, issued by the Rationalist Press Association (Watts and Co.; price 6d.).—This curious work, prefaced by some stirring remarks of Lady Florence Dixie, seems to infer that woman owes her present position of bondage and slavery to man entirely to "Superstitious Religion," that is, the word of the Bible. As soon as she chooses to give up a belief in this, she will be ready to throw off the yoke of masculine oppression. It is interesting to trace the position of woman in the various periods of history, and this is well detailed in the book.

Philip's Large Planisphere (G. Philip and Son, 6s. net).—Designed by H. Gewecke (and made in Germany). A large planisphere, this is 1 ft. 8 in. diameter, is useful, as showing more clearly the positions of the smaller stars, and the adjustment can be more accurate than with the more usual small size. But in this case, although "an attempt has been made to present a picture as closely as possible resembling the sky" it is in this respect not wholly satisfactory. Fourth magnitude stars are represented by small circles, which is decidedly confusing at first. While some of the constellations are indicated by allegorical figures in an inconspicuous grey, others such as Gemini, Aries, and Auriga are not thus depicted. In order to avoid encumbering the map, no lines of R. A. or declination are given, but positions are readily found by a graduated straight-edge, which can be adjusted to any point of R. A. marked on the circumference, while the declination is marked on this straight-edge. This large planisphere will undoubtedly be found a most useful addition to the amateur's observatory. —"K."

Historical and Modern Atlas of the British Empire, by C. Grant Robertson, M.A., and J. G. Bartholomew, F.R.S.E., F.R.G.S. (Methuen); price 4s. 6d. net.—This is a most useful and handy little atlas, specially prepared for students, but also likely to be of value to all those who wish to learn more of the great Empire to which they belong (or do not belong). The first few pages are devoted to a short but concise account of the British Empire, including an alphabetical gazetteer, tables of statistics, and index to names. Then follows a series of most interesting and well executed maps descriptive of the growth of the Empire at various periods in history. Maps of the world showing natural features, density of population, commercial development, &c., are given. Then a number of maps of England, Scotland, and Ireland, to show vegetation, coal and iron, industries, population, physical features, and political divisions. Numerous maps of India, Canada, South Africa, and Australia follow, and the atlas ends up with a table of the "Chronology and Expansion of the British Empire."

Divine Dual Government. A Key to the Bible, to Evolution, and to Life's Enigmas, by William Woods Smyth (Horace Marshall); price 6s.—The subjects which this book professes to cover are so appalling in their magnitude and "unknowableness," that we hesitate before lightly casting it aside with a few commonplace remarks. The author commences with a preface in which he explains that his own interpretation of the works of Darwin and Herbert Spencer are so different from the interpretation of them by other writers that he has "always attributed them to the direct teaching of the Spirit of God." Glimpses are taken of early history and the dawn of revelation. There is much that is of interest in comparing the words of the Bible with scientific theories. Some may think the perversion of Biblical words and phrases may be carried too far. Thus the word "day" in Genesis, with reference to the Creation, is often supposed to imply a very different period of time to that which we know as day. The author supposes it to mean 10 million years. But he clearly shows how difficult it is to arrive at any certainty when speaking of any such vast period. We can recommend anyone who wishes to investigate such subjects to study this book, although we would not say that personally we are at all satisfied with many of the conclusions arrived at.

The same author sends us a little pamphlet on "the Cost of Man's Creation and Redemption in the light of Natural Science," which is of much the same nature as the book.

The Theory of Experimental Electricity. (Cambridge University Press.) W. C. D. Whetham, F.R.S.; 8s. net. This text-book represents a course of class lectures delivered at Trinity College, Cambridge, and is intended to be a book of reference to which students may turn for further elucidation of points not clear to them. It is no mere cut-and-dried account of classical electricity, but aims at giving also "some insight into methods of research together with some idea of recent results, and of unsolved problems ripe for examination." The subject is thus presented as a living one, and this tends a great deal towards the making of a most interesting volume. But on the other hand the historical side is not neglected; in the case of the introduction of any fresh fundamental fact or principle, a brief but clear account is presented of the particular mode in which the fact was first learned. The chapters which will probably be turned to first by the reader who has already mastered the rudiments of the subject are those on conduction in gases and on radioactivity. So much of the new work on these questions has been done by the Cambridge School that we naturally look to it for a satisfactory exposition of it, and we are not disappointed. Further, the text is exceedingly well printed and the diagrams are wonderfully clear.

The Scientific Roll and Magazine of Systematised Notes. Bacteria. Conducted by Alexander Ramsay. Published by R. L. Sharland, 38, Churchfield Road, Acton, W.; 1s. This quarterly magazine has now ceased to be a mere recording roll of classified Bacteria. Useful, as it no doubt was, to a limited number of students, it may now claim a wider interest by reason of its containing readable matter. The conductor, wisely we think, promises in future numbers to introduce bacterial studies bearing on the problems of Health and Agricultural Economy. A more than something is known of the Bacterial Causation of Human disease, and our knowledge is rapidly extending. The same cannot be said of the Bacteria of the Soil; agriculturists know nothing of the bacterial invasions leading to the birth, growth, and decay of crops, &c., or of those producing disease in the same. Mr. Ramsay promises to enlighten us in this work on these problems, among others, and so benefit scientists in particular and mankind in general. This is the fourth year of the "Roll's" existence. Under its new development it promises to have an extended and successful future.

S. G. M.

An Introduction to the Infinitesimal Calculus. Dr. H. S. Carslaw (Longmans; 5s. net).—This book is written specially for 1st-year science and engineering students by the Professor of Mathematics in the University of Sydney. The object has been to present the fundamental ideas of the Calculus in a simple manner, and to illustrate them by practical examples. It will prove a very useful little book for use, especially in technical schools. Although rigorous proofs are as a rule avoided, there is little in the book which anyone would need to unlearn on going on to a higher stage. We commend it also to anyone who wishes to teach himself the elements of the Calculus as being very clear and likely to help him over the difficulties which beset the private student in his initial attempts to tackle this somewhat formidable but fascinating and important subject.

Leather for Libraries, by E. Wyndham Hulme, J. Gordon Parker, A. Seymour Jones, Cyril Davenport and F. J. Williamson. Published for the Sound Leather Committee of the Library Association (Library Supply Co.); 1s. 6d. net. This is an important little work, since every book-lover wishes to know what is the best material with which to bind his volumes, and many, sorrowfully noting an unexplained deterioration in their bindings, are most anxious to know the cause and remedy. Here is a practical and unbiassed account dealing with the technics of leather, and clearly setting forth the causes of decay, the methods of preparation, and the most suitable kinds of leather for bookbinding.

Machine Construction and Drawing, by Frank Castle (Macmillan) 4s. 6d. This is a useful guide to students and others to learn the practical details of machinery with the object of making working drawings. Such details as rivets, bolts and nuts, shafting, belt pulleys, bearings, pipe joints, and parts of engines are fully described with specimen drawings.

We have received a new catalogue of telescopes, &c., by Messrs. R. and J. Beck. This includes many instruments suitable for the amateur astronomer, especially 3-inch telescopes, and various stands and mountings. There are also astronomical cameras, microscopes for star photographs, diffraction gratings, theodolites, and other instruments.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Recent Work on Sunspot Spectra.

Two important papers dealing with the special features of the sunspot spectrum have recently been published. W. M. Mitchell, observing at the Princeton Observatory (which has been rendered notable by the work of Professor C. A. Young on the solar chromosphere and spots), has given a long list of specially affected lines, an analysis of which confirms the interesting results of previous observers that most of the chief lines concerned are due to the rare elements vanadium, titanium, and some unknown elements. Many of the chief lines were observed as reversed, giving bright centres to the lines.

G. E. Hale furnishes a long list of lines observed in the spectra of spots photographed with the magnificent equipment lately installed at the Solar Observatory on Mount Wilson in California by the Carnegie Institution. The beautiful illustrations accompanying the paper will convince many who may still have lingering doubts as to the reality of these specialised phenomena of the sunspot spectrum. In the analysis of the lines observed, the lines chiefly affected are ascribed to titanium; then come lines of manganese, chromium, calcium, iron, nickel, and cobalt. It is specially noticed that all of the lines of silicon in the region examined are much weakened. Many of the "*spot band*" lines have been photographed and are identified with faint lines in the Fraunshoferic spectrum.

Variation of the Figure of the Sun.

From a further examination of solar measurements made by Schur and Ambronn with the heliometer at Gottingen during the period 1890-1902, C. L. Poor has obtained more evidence in confirmation of the reality of the variations of the sun's figure which he put forward a short time ago. These later measures cover a whole sunspot period of 11 years, and they show a decided periodicity, the polar diameter being larger in 1890-1, while the equatorial diameter was greatest during 1892, 1893, and 1894. The exact length of the period is uncertain, but it appears to be nearly the same as the sunspot period. The amplitude of the variation is about 0''·2; the difference between the largest positive and negative values being about 0''·5. These heliometer measures thus corroborate the conclusions previously determined from Rutherford's photographs, but the amplitude of the variation is much less in the case of the visual observations.

New Astrographic Refractor for Cincinnati Observatory.

We hear that the Cincinnati Observatory has recently placed an order with Messrs. T. Cooke and Sons, of York, for one of their triple photovisual astrophotographic objectives. The aperture of the new lens will be 9·5 inches, and its focal length 67·7 inches, so that one millimetre on the photographic plate will be equivalent to two minutes of arc, this scale being half that of the International Astrographic series of negatives.

It will be noticed that the ratio of aperture to focal length, or intensity, of the new lens is 1 : 7, much greater than the usual ratio of 1 : 18. Moreover it is confidently stated that the objective will give good definition over a field fully 15° in diameter, and so should prove specially satisfactory for photographing comets, nebulæ, and asteroids. This new photographic equipment will be attached to the tube of the old 11-inch refractor at present mounted in the Mitchell Memorial Building.

Annular Nebula in Cygnus.

M. G. Tikhoff has recently communicated to the *Comptes Rendus* an account of a series of photographs of nebulæ he has obtained at the Meudon Observatory. Some of these show very interesting details of the Annular Nebula in Cygnus, N.G.C. 6894. They were taken with a telescope of one metre aperture and three metres focal length, with exposures from $2^h 20^m$ to 3^h, on September 27 and October 27, 1900, respectively. The nebula is in the form of an elliptical ring with a central condensation. The major axis is about 44''·8, and the minor axis 37''·3. It is composed of two rings, an exterior broad one and an inner portion somewhat thinner. On the north-west portion the doubling is interrupted by the presence of the star discovered by Lord Rosse in 1855. On the outer ring there are several condensations, of which the two strongest are almost opposite the above-mentioned star. Although the general similarity of this nebula to the well-known and brighter Ring Nebula in Lyra is noticeable, it differs in possessing these condensations, while the Lyra nebula is almost uniform in structure; and it is thought that this circumstance indicates a considerable advance of the Cygnian body from the evolutionary standpoint.

Occultations of Aldebaran.

On March 2nd and 29th the occultation of the bright yellow star Aldebaran will offer facilities for several interesting observations. Those possessing small telescopes up to 4 ins. aperture should look specially for the small companion, of about the eleventh magnitude, which is considered a good light test for instruments of this size. It is within 2' of arc in distance from Aldebaran. The other minute attendant star found by Burnham about 31''·4 distance is not considered to be physically connected with the Aldebarian system. At various previous occultations of Aldebaran observers have recorded a slight tendency for *projection*, or hanging-on, of the star. Although this might be caused if the companion star were brighter, it is doubtful if it be real, and observations carefully made to solve this question would be welcomed.

Harvard College Observatory, Report for 1905.

In his report for the year ending September 30, 1905, Professor E. C. Pickering has again an enormous amount of work to record. With the East Equatorial over 13,000 photometric light comparisons have been made by Professor O. C. Wendell, principally with the polarising photometer with achromatic prisms. A large part of these relate to variable stars of the Algol type, and serve to determine their light curves and times of minima. Measures have been made of four Asteroids, to determine the variation, if any, in their light. Thus from 1580 determinations of Eunomia (15) it appears that this asteroid varies by about half a magnitude in a period of $3^h 24·5^m$. With a second photometer, measures have been made of the remarkable variable O Ceti and several double stars.

With the 12-inch meridian photometer, 81,284 settings have been made by the Director, on 148 nights. The measurement of all the Durchmusterung stars in zones 10° wide, at intervals of 5°, has been completed from the North Pole to declination − 20°.

With the 11-inch Draper telescope, 1001 plates of spectra were taken, and 133 with the 8-inch Draper telescope. The number of photographs taken during the year is 6161. Eclipses of Jupiter's satellites and occultations of stars by the moon have been photographically recorded, and work is proceeding with the classification and study of the spectra of stars of about the fifth magnitude, during which study many interesting new variables have been detected.

In connection with modern observatories near, or in, large towns, a special inquiry has been made with regard to the photographic brightness of the sky. It was found that owing to electric lights, &c., the sky at Cambridge, Mass., is three times as bright as at points only a few miles distant, and it is suggested that it may be necessary in the future to establish an auxiliary observing station for the northern stars.

Stellar photographs at Arequipa were taken with the 13-inch Boyden telescope and the 8-inch Bache, to the number of 2244.

The Bruce telescope has been in full work, 523 photographs being obtained, of which 27 had an exposure of 4 hours. From a study of these, 1129 new variables have been detected, 909 being in the small Magellanic cloud. Other photographs led to the discovery of Themis, the tenth satellite of Saturn. This is sometimes brighter or fainter than Phœbe, and the latter appears to be variable. The Blue Hill Meteorological Station has been maintained, as before, at the expense of Mr. A. L. Rotch. During 17 kite records of the upper air, the average altitude was 6940 feet, and the maximum height attained was 11,180 feet. With *ballons-sondes* a height of 48,700 feet was reached, the temperature recorded being − 111° F.

BOTANICAL.

By G. MASSEE.

Floral Colours and Pigments.

THE colours of flowers, from a biological standpoint, have received much attention during recent years, but, as a rule, the colour, as we ordinarily see and interpret it, has formed the main or only basis for comparison. In the *Journal of the Royal Horticultural Society* Mr. Bidgood has treated the subject from a different and more fundamental standpoint. Plants do not inherit colour from their parents, but the pigments which possess colour or colours as their most characteristic properties. Further, if a pigment is inherited it does not necessarily follow that the colour of that pigment should be of the same hue as that of the parent. A plant may inherit from one parent an uncoloured substance which, with a pigment from the other parent, as in the case of a hybrid, may modify the pigment so that the colour is altered. Finally, a hybrid may inherit an uncoloured substance from each parent, which may re-act on each other and produce a pigmented or coloured substance. It is indicated that knowledge of this kind should prove very useful to those interested in hybridisation and the production of new colour varieties of plants, as it would prevent much time being wasted, and a striving after the practically impossible. Students of Mendel would also benefit by devoting more attention to the inheritance of pigment, rather than to the inheritance of colour.

A flower is seen by the light given off from its surface, much of it after having penetrated to a greater or less extent, and after having been more or less decomposed by the pigments present in the cells. If the pigmented particles consist of green corpuscles or chlorophyll grains, underlying a red dissolved pigment, the chlorophyll would absorb nearly all the light that passed through the red solution, and little or none would reach the surface again. The result would be a dark neutral brown or black. The outer side of the flower of *Crocus aureus* has green stripes near the base. This colour is due to the combined effect of blue anthocyanin in the epidermal cells on that side, and to a yellow xanthic pigment on the other. The black blotches on the leaves of *Arum maculatum* are the result of crimson anthocyanin overlying green chlorophyll.

Subjective colours due to the interference of light in thin films, frequently seen in animals, does not appear to exist in plants.

Relations of the Algal Floras of the N. Atlantic, the Polar Sea, and the N. Pacific.

It has long been known that a great many plants in the northern hemisphere have a circumpolar distribution. Plants of the tertiary period occupying districts around the Pole were driven southwards to the Continents of our time during the glacial period, and on its cessation slowly wandered back to their original home. At the same time these plants left some of their representatives in their southern temporary home. By these means we account for those species which every Arctic district has in common with the mountains south of it, but not with other districts. This knowledge, however, only applies to flowering plants, and as far as marine alga are concerned but little has been attempted in this direction previous to the work by Simmons in the *Botanischen Centralblatt*. In early tertiary times the Polar Sea possessed a distinct flora limited from the Atlantic flora by a land-bridge now absent. A similar barrier also separated the Pacific Ocean from the Polar Sea. On the disappearance of these barriers the Polar algæ invaded the Atlantic and Pacific, and the glacial period drove more algæ south, leaving the Polar Sea almost devoid of plant life. After the glacial period some algæ returned to their old home, and this condition of things is still in progress so far as conditions allow. Many of the tertiary Polar species have, however, not been able to return, owing to adverse conditions. As a result there are now some Atlantic and Pacific algæ respectively that had their origin in the Polar Sea, but are now absent from there. On the other hand, some old Atlantic algæ that became adapted to cold during the glacial period, migrated to the Polar Sea along with the returning original Arctic algæ. This theory accounts for the heterogeneous assemblage of types of algæ in the Polar Sea at the present day, and also for the presence of Arctic types in what are considered indigenous species in the Atlantic and Pacific Oceans respectively.

On the Occurrence of Starch and Glucose in Timber.

A point of much economic importance has been announced by Professor Kirk in the *Transactions of the New Zealand Institute*. Examination of a considerable series of worm-eaten wood of various kinds showed that in every instance such wood contained starch or an abundance of glucose, and it is for the purpose of feeding on these substances that the larvæ of beetles attack timber. In the case of white pine (*Podocarpus dacrydioides*) it is recommended that the trees be cut when the stored starch has been converted into soluble glucose, and the timber allowed to remain exposed for some time to the action of water to dissolve out the glucose.

Mycorhiza on Roots of Trees.

The presence of mycorhiza or growths of fungus mycelium on the roots of many plants has long been known, and various investigators, more especially Frank, consider that such growths are of great service, if not even indispensable to the nutrition and health of the plant thus infected. Transeau in discussing the flora of the bogs of the Huron River Valley, in the *Botanical Gazette*, expresses the opinion, founded on field observations, that in *Larix* mycorhiza are only developed when the ground in which the plant is growing lacks aeration, and more especially when the roots are surrounded by water. Acidity of the medium in which the plant is growing does not favour the development of mycorhiza. Whether the fungus is of actual advantage to a plant, even when growing in a poorly aerated soil yet remains to be determined. These conclusions corroborate those of others who have recently studied the subject, and point to the conclusion that the amount of importance attached to mycorhiza by Frank is exaggerated.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Poisonous Plants used for Catching Fish.

THE number of tropical plants which find a practical use in the catching of fish is very large, no fewer than 344 different kinds having been described by M. Greshoff. They belong to different families, but chiefly to the leguminaceæ, euphorbaceæ and sapindaceæ. The active chemical constituents to which they owe their toxic power are equally varied, and include alkaloids, glucosides, volatile oils, resinous bodies, prussic acid, etc. The compounds of most frequent occurrence have been found by Dr. Kobert to belong to the saponines, the best known example of which is found in the soap-wort, in the root of the clove pink, and in the horse chestnut. When extracted from these by means of boiling alcohol saponine is deposited as a powder when the solution cools. It is readily soluble in water, and the solution forms a lather like soap, whence the name of the compound. Dry, powdered saponine produces sneezing when inhaled. Another class of substances has been isolated by Dr. Greshoff and other Dutch chemists from leguminous plants belonging to the natural order *Derris*, and notably from the root of *D. elliptica*, which occurs in Java and the neighbouring islands, and has been especially studied by

Herr Pabisch. They are all resinous bodies, free from nitrogen, apparently related to one another, and extremely poisonous to fish. The compound isolated from *D. elliptica* is termed *derride*, and has the formula, $C_{[illegible]} H_{[illegible]} O_{10}$.

The Distillation of Gold.

M. Moissan, to whom we owe so much of our knowledge of the behaviour of chemical elements at a high temperature, has found that there is no difficulty in distilling gold in an electric furnace, and that the liquid condenses on a cold surface in minute crystals and threads, which behave exactly like ordinary gold in a finely-divided state. The boiling point of gold is higher than that of copper or tin, but lower than that of lime; so that on distilling alloys of gold with copper or tin a fractional separation is effected, the gold being the last to pass over. When an alloy of gold and tin is distilled with lime, the distillate, consisting of a mixture of gold, oxide of tin, and lime, has the beautiful colour and other characteristics of the well-known *Purple of Cassius* used for colouring glass and porcelain. Hitherto this substance has only been produced by wet methods, such as treating a solution of gold in *aqua regia* with solutions of the chlorides of tin, and the new dry method of preparing it may be found of commercial importance. Deposits of other shades of colour can be obtained by mixing the alloy with silica, magnesia, alumina, or other oxides, in place of lime, before the distillation.

Flour Dust Explosions.

Fine, dry, organic dust, such as that of coal, flour, soot, or cotton, will take fire with explosive violence, and many terrible accidents have occurred in mines and mills through ignorance of this fact. After the explosion in the Haswell Collieries in 1844, the subject was investigated by Faraday and Lyell, who made recommendations as to better ventilation of the mines; but no precautions appear to have been adopted until later accidents led to the appointment of a Royal Commission. In 1872, a frightful disaster took place in the Tradeston flour mills, near Glasgow, but no one suspected the cause until Mr. Watson Smith showed that a mixture of flour dust and air would burn explosively in the same way as coal dust and air. An investigation made in 1881 by Messrs. Rankin and Macadam, brought to light the fact that many unexplained explosions had occurred in other flour mills, notably in Buda-Pest. These, too, were attributed to the dry flour dust having been ignited by sparks from the stone rollers, and the conclusion was arrived at that "it seems scarcely possible to guard against such accidents." Mr. Watson Smith has reviewed the whole subject in a paper read before the Society of Chemical Industry, and points out that to this day flour mills of the old type are still in use and are inevitably exposed to the same risks as the mills in 1881, notwithstanding the fact that means of obviating all danger were devised by Mr. Simon, of Manchester. These improvements consisted in replacing stone rollers by iron rollers, and in the introduction of what is known as the "Cyclone" System of collecting the flour dust. The dust-laden air from the rollers is conducted into a conical separator where, by means of the centrifugal action, the dust slides down the side to the bottom, and escapes through a small opening into a receptacle, while the air, freed from dust, is whirled upwards again, and leaves the "cyclone" through a cowl in the roof. In addition to the production of a purer flour, the method has the further advantage of preventing injury to the workpeople, who otherwise inhale the dust.

GEOLOGICAL.

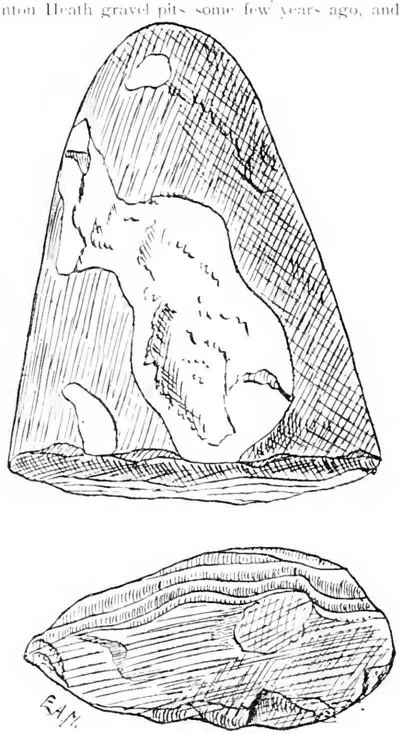
By E[illegible] A. Martin, F.G.S.

Glacial Beds of Triassic Age.

The Dwyka Conglomerate, found at the base of the Karroo System in the Transvaal, is now better known as the Glacial Conglomerate, since the former differences amongst geologists as to the nature of the formation have all but passed away. At one time it was generally supposed to have been of igneous origin, and great hesitation was naturally felt before accepting the glacial origin of the beds, situated as they are in a system which is certainly not younger than the New Red (Triassic). Mr. E. T. Mellor, F.G.S., has studied the district lying east of Pretoria to near Middelburg, and divides the Karroo rocks into an Upper and a Lower division. The former is sometimes known as the "High-Veld Series," and consists of various grits and shales with conglomerates and coal seams, whilst the latter consists of various glacial deposits, including the Dwyka Conglomerate, and associated shales and sandstones. The conglomerate averages about 50 feet thick, and may in depressions reach as much as 200 feet. The constituent boulders and sub-angular rock fragments show no definite arrangement, and lie in a confused mass. It is noteworthy that the surface of the older rocks underlying the glacial conglomerate are frequently polished and clearly striated, and also that the striæ exhibit a remarkable constancy of direction towards the south.

Neolith from South Norwood.

A portion of a neolithic flint implement has reached me which was found in a garden in South Norwood, on the slope of the hill below Grange Park. It bears a marked resemblance to one that was found by a workman in the Thornton Heath gravel pits some few years ago, and was



Neolith from South Norwood. (Natural size.)

referred to by Dr. A. E. Salter, F.G.S., in his paper before the Geologists' Association, entitled "Pebbly Gravels." The portion of an implement now found is well preserved, although on both sides a molecular change has proceeded in the silica, resulting in a banded appearance of the white portion when seen in section below. It is of excellent shape, and well polished.

Nilotic Geology.

The somewhat vexed question of the mutual relations of the Cretaceous and Eocene systems in the valley of the Nile has been to some extent determined by some useful observations which have been made by Mr. H. J. L. Beadnell, formerly of the Egyptian Geological Survey. In the autumn of 1904 he took advantage of certain opportunities which presented themselves to him to examine the desert margins on both sides of the Nile Valley, between Aswan and Esna (lat. 24° to 25½°). Far from the Cretaceous and Eocene formations being here at all times unconformable with one another, there is distinct evidence that the passage from the oldest to the youngest beds was in some localities, notably near Ain Amur, so gradual that near the junction, fossils typically characteristic of Cretaceous beds in other places, occurred side by side with forms having distinct Eocene affinities. On the other hand, in the Baharia Oasis, the unconformity is most strongly marked. Of the Cretaceous beds, the Danian stage is clearly shown, whilst above these beds, and below the Lower Libyan (Eocene), Mr. Beadnell found it necessary to classify the Esna shales as passage beds, some 197 feet thick, since they undoubtedly bridge over the period which elapsed between the deposition of the Cretaceous white chalk and the incoming of the Nummulitic sea of Eocene times.

Ripple-Marked Sandstone Tiles.

With a plentiful supply of slates and tiles for the roofing of houses, the use of ripple-marked slabs of sandstone is not now, perhaps, so noticeable as formerly. Formerly the fissile slabs of Wealden sandstone, on which a long-ago incoming tide had left the impress of its ripples, were in great

demand, and many of the older Wealden farmhouses may be seen to be roofed with them. The illustration shows a farmhouse near Bletchingley, in Surrey, roofed with somewhat substantial sandstones, many of which are very clearly ripple-marked. These may be of Lower Greensand age.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Bird Migration.

THE first Report of the Committee appointed by the British Ornithologists' Club for the study of the migrations of our British birds has just been published, and forms an exceedingly valuable contribution to our knowledge of this subject. The work began early in 1905 when schedules were distributed among a number of willing workers in England and Wales—to which areas the observations are to be confined for the present—and to numerous lighthouses and lightships. Over 15,000 records were received, and the report in question gives the results of the analyses of these.

The work for this year was confined entirely to the arrival and dispersal over the country of twenty-nine of our commonest summer visitors—the warbler, swallow, swift, nightjar, cuckoo, and land-rail being among the number.

It would seem from the report that, in some species, at any rate—as the whin-chat and chiffchaff—the birds which arrived first passed on northwards to nest, their place being taken by later arrivals; while the western and north-western counties of England were populated before the eastern and north-eastern.

Space, however, forbids a further summary of the results of the first year's work, which is full of most interesting facts, and should be read and studied by all who are interested in this subject. The great feature of this admirable digest are the maps which illustrate the movements of the species dealt with. Those who desire to obtain copies of the report should write to the publishers, Messrs. Witherby and Co., High Holborn.

Bittern in Essex.

The *Field*, January 20, records the fact that a bittern was seen within twenty-five miles of London on the 11th of this month. It was surprised by a sportsman in some sedgy growth "surrounding a large piece of water" and was, to his credit, allowed to escape unharmed.

Ferruginous Duck in Suffolk.

Two examples—sex not stated—according to the *Field* of February 3 were shot during the end of January near Bury St. Edmunds.

Wall Creeper at Ecclesbourne.

At the last meeting of the British Ornithologists' Club an example of the wall creeper (*Tichodroma muraria*) was exhibited which had been shot while climbing about the face of the cliff at Ecclesbourne, near Hastings, on December 20, 1905. It proved, on dissection, to be a female. This makes the fourth occurrence of this bird in Great Britain.

Dusky Thrush in Nottinghamshire.

At the meeting of the Club just referred to an example of the dusky thrush (*Turdus fuscatus*) was exhibited, which had been shot by a market gardener near Gunthorpe in October, 1905. This makes the first recorded occurrence of this bird in these islands.

Fire-Crested Wren.

There was also exhibited a male example of the fire-crested wren (*Regulus ignicapillus*), which had been shot at Wimbledon, December 31, 1905. This marks the first occurrence of the bird in Surrey. Another example, also a male, was exhibited by Mr. W. R. Ogilvie Grant, which had been picked up in a dying condition at Abbey Wood, Kent, January 10, 1906.

An Abnormal Eider.

A more careful scrutiny of our eider ducks would seem to show that occasionally at least specimens occur with a more or less distinct V-shaped mark on the throat hitherto supposed to obtain only in the Pacific eider. An example of this kind was exhibited at the meeting above referred to by Mr. Howard Saunders, which had been killed on December 7, 1905, near Stromness, Orkney. Whether this peculiar mark is the result of a cross with the Pacific species which occasionally occurs in our waters, or is independently developed, it is impossible at present to say.

PHYSICAL.

BY ALFRED W. PORTER, B.Sc.

Do Rontgen Rays Disintegrate Atoms?

ALL substances when illuminated by Röntgen rays or by Becquerel rays of the γ type give out a complex secondary radiation, part of which at least is wholly different in character from the primary radiation. For example, the secondary radiation due to the absorption of Rontgen rays consists in part of negatively charged corpuscles or electrons, although no such charged particles exist in the exciting rays. This suggests that there may be some breaking up of the substance upon which the exciting rays impinge—a disintegration of the same type as that which takes place spontaneously in radio-active substances. On the other hand, the production of streams of electrons by no means proves that such disintegration is a fact; for according to modern theories of electric conduction there exist numerous electrons in a conductor—and what substance is not a conductor?—which are only loosely attached to the atoms and not apparently forming an integral part of them. They seem to float about very much as the particles of gas dissolved in a liquid. The electrons which leave the substance under the action of Röntgen rays may simply be these unattached ones, and if so the existence of the streams is no proof of atomic disintegration. This question has recently been tested by Professor Bumstead (working in the Cavendish Laboratory), who argues that if disintegration is brought about there must be a corresponding release of atomic energy, which will appear—in the main—as heat, and which will raise the temperature of the substance. For equal absorption of Röntgen rays the amount of heat produced from two substances might be expected to depend upon the material and be greater in amount than that of the incident rays, which merely play the part of a trigger. But if no disintegration occurs the heat produced should be equal to the energy of the incident radiation (minus the small amount carried away by the secondary radiation), and should therefore be practically the same in both cases. The experimental method employed is based upon these considerations. It is in brief a sort of reversed radiometer. A radiometer—such as was first devised by Crookes—acts owing to the incident light warming the vane which is repelled by the forces in *the air* between the vane and the fixed wall of the tube. It comes to the same thing if the wall itself is warmed while the vane is made transparent so as to keep cool. The latter arrangement was most suitable in the present case. The walls can be made of the metal under investigation, and the movement of the suspended vanes is due to the warming of the walls by Röntgen rays, and is a measure of the heat produced.

Only lead and zinc have been experimented upon so far. Their thicknesses were chosen so that they absorbed the same amount of radiation, and under these circumstances the experimental result is that about twice as much heat is generated in the lead as in the zinc.

Professor Bumstead examines the numerous sources of error to which the mode of experimenting is subject; and also other modes of explaining this difference in heat production; but concludes that the evidence is in favour of the view that true atomic disintegration is brought about by the absorption of Röntgen rays. The experiment is, however, beset with pitfalls, and physicists will probably await the results of further experiments, which are promised, and in which it is proposed to employ other means of measuring temperature, such as a thermopile. Anyone acquainted with the vagaries of a radiometer will regard with caution the conclusions arrived at from these preliminary experiments, even though he may be willing to grant their plausibility.

("PHILOSOPHICAL MAGAZINE," Feb. 1906.)

Conductivity of the Vapour from a Mercury Arc.

The Hon. R. J. Strutt showed some years ago that mercury vapour under ordinary conditions is a very perfect non-conductor of electricity. C. D. Child, in a recent paper read before the American Physical Society, shows that the vapour coming from a mercury arc is highly conducting. A luminous space gradually spreads out from the arc, and the front of this region has the greatest conductivity and the greatest luminosity. He considers that the conductivity is not due directly to ions coming from the arc, nor to rays sent out by it, nor to leakage over the surface of the glass, and probably not to the high temperature of the gas. He suggests as probable an explanation given by Merritt, viz., that when ions recombine they are at first in a condition of unstable equilibrium much like the atoms of radioactive matter, and that many of these combinations break up again into positive and negative ions.

The Efficiency of a Welsbach Mantle.

A fresh study has been made by Rubens of the light from a Welsbach mantle with the object of elucidating the reason of the extraordinary efficiency of this source of light. The fact that the small addition of cerium oxide (·8 per cent.) to the thorium oxide which forms the main body of the mantle (99·2 per cent.) enormously increases its light-giving power has induced many—especially among chemists—to regard the light as being essentially of phosphorescent origin—*i.e.*, as depending in the main upon chemical changes (or catalytic action) rather than upon the high temperature to which the mantle is raised. It is well known that at a given temperature, the radiation which depends upon temperature can never exceed that from a "perfectly black body" at the same temperature. Since a mantle without ceria and one with it give out very different light when placed in the same Bunsen flame, the assumption that the additional light is not due to the temperature has at least some plausibility. But nothing except a thorough study of the radiation can suffice to settle this interesting question. For there is a tacit assumption amongst the holders of the chemical theory that the two mantles placed successively in the same flame will have the same temperature. It is clear, however, that if one radiates much *more* than the other it will necessarily adjust itself to a *lower* temperature; for it is the gradient of temperature from the flame to it which controls the flow of energy to the mantle and which maintains this mantle at a constant temperature in spite of its radiation. The one that radiates most has to receive most, and a greater gradient is necessarily required to keep up the supply. Those who claim that no chemical change is responsible for the light assert that the more luminous mantle owes its luminosity to the fact that at a given temperature it is *a bad radiator for that temperature*; but that owing to this parsimony it is able to keep *at a higher temperature* than its more generous companion; and everyone is agreed that a higher temperature tends to produce greater efficiency.

The upshot of Rubens' measurements is that a mantle stained with iron oxide (and therefore a good radiator at a given temperature) kept at a temperature of about 1050° C. in a flame; whereas the unstained mantle rose to about 1500 C., while the estimated value of the temperature of the bunsen flame itself is about 1800° C. After making allowance for the non-continuous nature of the surface of the mantle, it is shown that *for no wave length* is the radiation as great as that from a perfectly black body at the temperature of 1500° C.; and that the total energy radiated is only one thirty-third part as great as from such a body. Although then it cannot be denied that phosphorescence may play some small part, yet it is altogether unnecessary to call in its aid to explain the amount of radiation.

Experiments on a mantle of pure thorium oxide show that the radiation from it contains almost no light rays, but in other respects is very nearly the same as for an ordinary mantle. On the other hand, a mantle of pure cerium oxide gives out radiation proportionately very rich in luminous radiation, and also of radiation of *very* long wave length. For the important region of wave lengths immediately in the infra-red (*i.e.*, $\lambda = 1$ to 8-millionths of a metre) it is a bad radiator. It would not do, however, to use such a mantle, for its temperature (like the iron-oxide one) keeps very low. But the addition of a small amount of ceria to thoria much increases the luminous radiation of the latter without sensibly alterating the radiation in the immediate infra-red. Thus the behaviour of an ordinary mantle can be adequately represented by adding together the separate radiations of the constituents of the mantle. The opposite supposition, that the light is due to phosphorescence, requires that the greater part of the effect should arise only when the constituents are present together. This result seems to be in conflict with the new experimental data.

ZOOLOGICAL.

By R. LYDEKKER.

The Intestinal Appendages of Birds and Mammals

An important contribution to our knowledge of the intestinal anatomy of mammals has just been published in the *Transactions* of the Zoological Society, Dr. Chalmers Mitchell, the Society's secretary, being the author. Perhaps the most generally interesting feature in this memoir is the identification of the paired "cæca," or blind appendages of the intestine, of birds with the, usually, single cæcum of mammals. These cæca occur at the junction of the small with the large intestine; and while in ordinary perching birds they are reduced to small nipple-like buds of no functional importance, in many other birds—owls for instance—they form quite long receptacles. Among mammals, the horse and the dog may be cited as instances where the single cæcum is of large size, this being especially the case in the former, where it is of enormous dimensions; in human beings, on the other hand, the cæcum is rudimentary, and best known in connection with "appendicitis."

The existence of paired cæca was previously known in a few armadillos and ant-eaters, but Dr. Mitchell has now shown that they are quite common in these groups, while he has also recorded their occurrence in the hyrax and the manati. With the aid of these instances of paired cæca, coupled with the frequent existence of a rudiment of its missing fellow when only one is functional, the author has been enabled to demonstrate conclusively that these double organs in birds correspond in relations with their normally single representative in mammals.

Teeth of Early Carnivora.

Much difference of opinion has obtained among naturalists with regard to the affinities of certain extinct carnivorous mammals from the Tertiary strata of South America, some authorities regarding them as more akin to the predaceous marsupials, while by others their relationships are believed to be closer with the primitive European and North American Carnivora known as creodonts. This opens up the wider question as to the existence of a direct relationship between creodonts and marsupials. On this difficult question considerable light has been thrown by investigations into the structure of the enamel of the teeth of the two groups, the results of which were recently communicated by Mr. Tomes to the Zoological Society. According to the author, marsupial teeth show in the structure of their enamel a well-marked peculiarity, namely, the free penetration of the enamel by tubes continuous with those of the dentine; while recent Carnivora, the descendants, more or less direct, of the creodonts, also present a disposition of the prisms of their enamel somewhat unusual amongst mammals. Teeth of *Hyænodon* and other extinct genera were examined, and in none of them were marsupial characters observed. On the contrary, in most cases characteristic carnivorous patterns were found, so that in Oligocene and Eocene times the enamel of the ancestral Carnivora had already attained the full specialisation characteristic of the modern group.

Weights of Whales and Dinosaurs.

With characteristic boldness and originality American investigators have recently been making the attempt to estimate the approximate "live-weights" of the huge dinosaurian reptiles of the Oolites, such as *Diplodocus* and *Brontosaurus*. Although at first sight the attempt might appear almost hopeless, their method of going to work has been so thorough and well thought out that there appears to be considerable probability of the estimates at which they have arrived presenting a fair approximation to the reality. The plan adopted was to make a model of the entire reptile, as deduced from a careful study of the skeleton, on a scale of one-sixteenth the natural size. The cubic contents of such a model multiplied by the cube of 16 would indicate the probable amount of water displaced by the reptile when in the flesh. To arrive at this result, one of the miniature models of *Brontosaurus* (the length of whose skeleton is 66½ feet) was cut into six pieces of convenient size for purposes of manipulation; and the equivalent water-displacement of each of these fragments determined with great accuracy in the laboratory. From this the water-displacement of a model of the natural size was calculated by means of the above-mentioned formula, which gave as a result the displacement of 34½ tons by the entire animal. Since, however, *Brontosaurus* is believed to have walked along the bottom of the ancient lakes in search of food to depths which would cause its whole body to have been submerged, it is probable that the reptile in life was slightly heavier than water, and to allow for this an addition of about ten per cent. was made to the calculated weight, thus bringing the final estimate to a total of 38 tons. Vast as is this weight, it is, however, only about two-thirds of the estimated weight of the heaviest whales, which is presumed to be not less than 60 tons. Further information with regard to this latter estimate appears desirable, and it would be interesting to know which of the larger species is really the heaviest. The Greenland right whale would, from its great bulk, of course weigh well; but as the maximum length of this species was estimated by Sir William Flower at from 45 to 50 feet, while the male sperm-whale is known to measure from 55 to 60 feet, it is possible that the latter monster would scale heavier than the former. On the other hand, despite its length of from 80 to 85 feet, the huge Sibbald's rorqual, on account of its "clipper-built" form, would probably weigh less than either the Greenland whale or the sperm-whale. Any estimates of the weights of whales based on trustworthy data would be of much interest.

It may be added that the weight of the African elephant "Jumbo" was only 6½ tons, and although some individuals of the species may perhaps be somewhat heavier, it is clear that elephants are not in the running in comparison with the American estimate of the weights of dinosaurs.

The Flight of Flying-Fishes.

In the course of a memoir on fossil flying-fishes, published in the Year-Book of the Austrian Geological Survey, Dr. O. Abel reviews the much-discussed question as to whether the existing representatives of such fishes which belong to two distinct groups, the flying-herrings, or true flying-fishes, and the flying-gurnards—really use their "wings" after the manner of bats, or whether such wings merely serve the same purpose as the flying-membrane or parachute of the flying-squirrels. In the case of both flying-herrings and flying-gurnards, the author denies that the wings are ever used as instruments of active flight. As regards the former, Dr. Abel's opinion agrees with that of the majority of competent observers. In regard to the flying-gurnards it has, however, been stated in the "Cambridge Natural History" that these fishes differ from the members of the former group in that the wings are moved rapidly during the course through the air, thus producing a mode of flight recalling that of many grasshoppers. This assertion is, however, controverted by Dr. Abel, who urges that such movements as take place in the wings of flying-gurnards are similar in their nature to the vibrations which are admitted to occur in those of the flying-herrings or true flying-fishes. The author's statement of the whole case is summarised as follows:—

"It may be taken as certain that the initial impetus by means of which flying-fishes of both kinds launch themselves is due to powerful screw-like movements of the tail-fin. The wings are in no sense propelling organs, but act simply as parachutes."

In striking contrast to this conclusion is one arrived at by an author in the January number of the *Annals and Magazine of Natural History*. According to this, the aeroplane theory, as the above may be called, is an absolute mechanical impossibility, and the flight of flying-fishes is due to incessant and extremely rapid movements of their wing-like fins.

A Male Fish-Nurse.

It has long been known that the males of the strange-looking pipe-fishes take charge of the eggs as soon as they leave the bodies of the female parents, and nurse them in a special pouch on the under side of their own bodies; but it appears to have been reserved for an American naturalist to observe the actual manner in which the transfer of the eggs takes place. From his account, it seems that the male and female fishes entwine their bodies in the form of a double letter S, and that in this position the eggs are passed from the mother to the pouch of the male. As might have been expected, all the eggs are not transferred at once. After the first transference all the eggs of this batch are in the upper part of the pouch, where no more can be received until these are shaken down into the lower end. "To bring this about," writes the narrator, "the male performs some very curious movements. He stands nearly vertically, and, resting his caudal fin and a small part of the tail on the floor of the aquarium, bends backward and forward, and twists his body spirally from above downward. This is repeated until the eggs have been moved into the posterior end of the pouch." These processes are repeated until the pouch is filled. In about ten days the young pipe-fishes are hatched.

Papers Read.

At the meeting of the Zoological Society held on January 16, Mr. O. Thomas exhibited skulls of a forest-pig from the Cameroons district, which he referred to a new species, under the name of *Hylochærus rimator*. Mr. W. S. Fox read a paper on bones of the lynx from a Derbyshire cave; Mr. C. S. Tomes discussed the structure of the enamel of the teeth in Carnivora and marsupials; Mr. F. E. Beddard described the results of investigations into the anatomy of snakes; and Dr. J. Roux contributed a list of the species of a particular group of toads.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page 362.*)

The utmost care must be taken in observing whether this disc of light is really uniform; it is somewhat deceptive, and a slight re-adjustment may sometimes make all the difference, but if it be not uniform, the photograph will show unequal illumination, that is, one side will be rather darker than the other, which is not satisfactory, though too often seen. The sub-stage condenser and even the auxiliary condenser may need slight re-adjustment and re-focussing to obtain the best results, but any great alteration will not be found satisfactory. A little patient experimenting, however, will be found to teach more than many pages of suggestions.

The advantage of the optical bench or of the parallel slides is now evident, and if there is any change of objective a slight re-adjustment of the condenser is all that is necessary. It saves much labour if everything is left in place, except the microscope, and the position of the latter is carefully marked, or stops made for its stand, but if the auxiliary condenser and illuminant must be removed, then some means should be adopted of so arranging or marking them that they can be, without difficulty, brought back exactly to their previous position when required.

So far, we have done all our focussing upon a piece of ground glass, but this, however fine it may be, will be found too coarse for the final focussing. We must, therefore, have a further frame of plain glass, fitting into the same slides, and once again I must insist on the importance of having the inner surface of this in exact correspondence with the sensitive film of the photographic plate when in its dark slide and in position. It is not a bad plan to fasten a thin circular cover-glass with Canada balsam, in the very centre of the inner and rough side of the ground-glass screen. This makes a little transparent disc for examining the photograph, but it is scarcely big enough to be an efficient substitute for the complete plain-glass screen. In using the latter we have, of course, no surface to form an image upon, and we therefore need a focussing lens of some sort. This may be of the simplest form, but its magnification should not be too high and yet its "depth of focus" should not, for manifest reasons, be too great. A dissecting loop in a cardboard or wooden ring will serve, or one of the ordinary tripod magnifiers, but suitable lenses with a ring for adjustment, can be bought for a few shillings at most opticians. An ink mark is made on the inner surface of the plain glass screen, the focussing lens is brought in contact with the other or outer side, and then adjusted so as to focus the ink-mark through the glass. Dr. Bousfield recommends a double convex spectacle lens of about eight inches focal length, which may be mounted in a cardboard or other tube of suitable length to focus such an ink-mark.

(*To be continued.*)

Journal of the Quekett Microscopical Club.

The half-yearly volume of this journal contains a detailed list of 140 species of Foraminifera, collected by Mr. Arthur Garland, from the shore-sand at Bognor, Sussex, with four illustration plates, also an illustrated article on the genitation of the Tsetse fly, by Mr. Walter Wesché. Mr. F. P. Smith contributes a list of all the species of spiders of the *Walckenaeria* group, which have occurred in the British Isles, and a description of a spider found at Yarmouth, which he believes to be a new species of the Erigone group. The Journal, in accordance with the economic policy of the Club, is considerably reduced in size, which is a matter for regret.

Royal Microscopical Society.

The annual meeting was held at 20, Hanover Square on January 7, the President, Dr. D. H. Scott, in the chair. Attention was called to a donation from M. Nachet, a Fellow of the Society, of six micro-daguerrotypes of blood, milk, crystals, &c., set in a frame. They were taken with the electric light by M. Léon Foucault in the year 1844, and are probably the oldest of their kind in existence. The photographs are of undoubted excellence, and will compare favourably with many of later date. There was also a donation of 15 slides of the Oribatidæ from Mr. N. D. F. Pearce, to supplement the collection presented by Mr. Michael. Some excellent photo-micrographs of diatoms and Podura scale were sent for exhibition by Mr. F. A. O'Donohue. The report of the Council and Treasurer's statement for 1905 were read and adopted, and the names of the officers and Council elected for the ensuing year were announced, Dr. D. H. Scott having been elected as President for a third term. The President delivered his annual address, the subject being "The Life and Work of Bernard Renault," illustrated with numerous lantern slides.

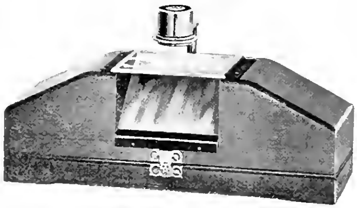
Quekett Microscopical Club.

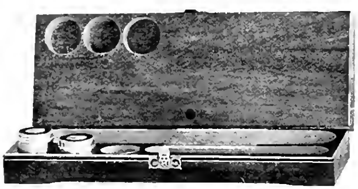
At the meeting held on January 19 at 20, Hanover Square, Dr. E. J. Spitta in the chair, Mr. R. T. Lewis delivered a lecture on "The Senses of Insects," dealing more especially with sight and hearing. Comparison having been made with the physiology and anatomy of such senses in man, and stress having been laid upon the important part played by psychological factors, the lecturer explained the theory of "Sympathetic Vibrations" and its possible applications. It was suggested that as insects live in the same light and air as man, similar, or, at least, analogous structures should be looked for, but that there was every probability that they were capable of appreciating a far greater range of vibrations of both light and sound, especially in the direction of the shorter wave-lengths. The auditory organs of insects presented a great variety of structure, those of the Orthoptera most nearly complying with what we might expect to find—organs designed to appreciate such sounds, for instance, as we might ourselves hear; but their position and number varied considerably in different families. It was considered that in addition to sight and hearing insects possessed the senses of taste, smell, and touch, and that some were endowed wth the "sense of direction." Mr. Lewis made an interesting statement regarding the figure in Carpenter reputed to be a reproduction of a photograph made by Exner through an insect's compound eye, calling attention to the fact that at a meeting of the Royal

Microscopical Society on November 19, 1890, Professor Bell exhibited a print of the original photograph, which he (the present lecturer) had roughly copied in his note-book, and which showed the letter R the right way round and not reversed as in Carpenter.

Barnes Dissecting Microscope.

Messrs. A. E. Staley and Co. have recently brought to my notice a simple dissecting microscope made by the Bausch and Lomb Optical Co., which is both practical, serviceable, and inexpensive. The body is of neatly finished light wood shaped to form hand rests. The stage is a glass plate, easily removable for cleaning. The mirror is as large as the stage, giving effective illumination. A black or white metal plate can be laid over the mirror when a black or white background is desired. The lens carrier is adjustable for focussing. The base forms a hinged wooden box with receptacles for magnifiers, tweezers, dissecting needles, &c. The whole stand, including an inch doublet lens with large flat field and good definition, costs only half a guinea.





Notes and Queries.

A., Hull.—I have put your query before a gentleman in Cambridge who is an authority on the Carboniferous Rocks, &c., and he considers that Harker would be most suitable for your purpose, but as you say you have this and it is not quite what you want, he suggests that you should endeavour to see Hatch's "Introduction to the Study of Petrology" and "Text-book of Petrology"; Geikie's "Structural and Field Geology," and Rutley's "Study of Rocks," and see if one or more of these will help you. Cole's "Aids to Practical Geology" is also useful. Of course, you will be aware, that the recognition of the constituents of rocks cannot be gained from pictures in books without a preliminary broad and general study of the subject. There seem to be no books dealing exclusively with the special subject in the way you require. I regret the oversight to which you call my attention.

D. B., Manchester.—I think both the books you mention are very suitable for your purpose. Strasburger is perhaps a little better than Bower for anyone working alone and unaided. I think you would find Watson's "Praxis" microscope satisfactory for all kinds of work, and would suggest your obtaining with it 2/3 and 1/6 inch objectives (Parachromatic series), the 2/3 being more generally useful than the 1/6 inch, and the 1/6 having a N.A. of ·87, and a No. 2 ocular. This would cost you, with case, £6 10s., but I strongly recommend your adding a "Scop" Abbe Condenser, with iris diaphragm, and an extra No. 4 eyepiece at a total cost of £7 12s. 0d.

C. C. Dobell and C. W. Archer.—I think the "ultra-microscope" to which you refer must be an allusion to Dr. Siedentoff and Dr. Zsigmondy's apparatus for the making visible of "ultra-microscopic particles." You will find an account of this in the "Science Year Book" for 1905, article "Microscopy," page 117, with further remarks in the issue for 1906, page 107; also in the Journal of the Royal Microscopical Society for October, 1903. The principle in brief is the focussing of an arc-light upon a small spectroscopic slit and condenser so as to pass a narrow beam of light at right angles to the optic axis of the microscope upon the particles to be made visible. According to Lord Rayleigh, there is nothing except lack of light to hinder the visibility of any object, however small; but if its dimensions are much less than half a wave-length, its apparent width will be illusory. In other words, the *existence* of the object can be shown if only the light be strong enough, but this will be no guide to its real appearance. It may be of interest to add that, accepting the size of a medium size molecule as $6\mu\mu$, a specific intensity of luminosity considerably exceeding the power of the sun's rays would be necessary to discern such molecules. It is advisable to lay particular stress upon the important difference between the mere making visible of an object and the seeing of it as it really is, as I find many workers with the microscope failing to realise this distinction, and thus entertaining erroneous expectations.

T. H. Russell, Edgbaston.—The only way to find out the magnification of eyepiece and ocular is to measure such magnification, and the easiest way is to project the image of a micrometer at a distance, as explained in Carpenter and other books on the microscope, and to make the necessary simple calculation. If you project the image of the micrometer on a sheet of paper at ten inches from the eye-lens of the ocular you will obtain a similar, if less accurate, result, but the distance *must* be ten inches if it is to correspond pretty closely with the magnification as seen visually through the microscope, because ten inches is the normal visual distance. If your paper is further away the magnification is proportionately greater, and no longer corresponds to that given when you look down the microscope tube. It must be evident that alteration of the tube-length will alter the magnification visually, and in just the same way upon the paper, but the measurement is always taken at ten inches from the tube length because that remains the visual distance of the eye whatever the tube length. Adjust the tube length as you will, you must always measure the *projected* image ten inches away, or, if more, you must reduce the result to what it would be at ten inches. I hope this is quite clear now.

Rev. J. B. Williams, Exminster.—Paraffin of various melting points is used for embedding and infiltrating specimens, one melting at about 50 C. being perhaps the most generally useful in a room temperature of about 16 C. With rocking microtomes a somewhat harder paraffin is better. Hard objects naturally require a harder paraffin than soft ones. Paraffin of various melting points can be readily obtained, but if your paraffin is too hard, you had better mix it with some of a lower melting point, rather than with any other substances. The paraffin in a section can be got rid of by soaking in xylol. Tissues are dehydrated with alcohols of variously graduated strengths, such as 30 per cent., 50 per cent., 75 per cent., and 96 per cent., taking care that sufficient time is allowed in each. Before embedding, the object must be soaked for a considerable time in cedar oil or clove oil. After the paraffin has been got rid of, you can proceed to stain at once in alcoholic stains, but if watery stains are used the object must be first passed back through the alcohols in reverse order, and then before mounting in Canada balsam the dehydration must be gone through again, finishing with a final soaking in xylol, cedar oil, clove oil, &c. The best all-round stains for vegetable tissues are hæmatoxylin, borax carmine (3 per cent. carmine to 4 per cent. borax in 70 per cent. alcohol, a concentrated solution being first made and afterwards diluted with an equal amount of 70 per cent. alcohol), methyl blue, and methyl green. Vegetable tissues must be first hardened for some days in methylated spirit. Cross and Cole's "Modern Microscopy" (4s.) contains very clear instructions for elementary mounting, and my own "Elementary Microscopy" (3s.) has also a chapter on the subject.

Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.

The Face of the Sky for March.

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

THE SUN.—On the 1st the Sun rises at 6.49 and sets at 5.37; on the 31st he rises at 5.41 and sets at 6.28. The Sun enters the sign of Aries at 1 p.m. on the 21st, when Spring commences.

The solar disc continues to be well marked with sunspots, and recent spectroscopic observations of the Sun's limb show many active prominences.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar. 2	21° 48′ W	7° 14′	205° 26′
,, 7	22° 59′ W	7° 15′	139° 33′
,, 12	24° 0′ W	7 12′	73° 38′
,, 17	24° 51′ W	7 5′	7° 44′
,, 22	25 32 W	6° 56′	301° 49′
,, 27	26 1′ W	6° 43′	235° 54′

The Zodiacal light should be looked for in the west for a few hours after sunset.

THE MOON:—

Date.	Phases	H. M.
Mar. 3 ..	☽ First Quarter	9 28 a.m.
,, 10 ..	○ Full Moon	8 17 p.m.
,, 17 ..	☾ Last Quarter	11 57 a.m.
,, 24 ..	● New Moon	11 52 p.m.

OCCULTATIONS:—The following are the occultations of the brighter stars visible at Greenwich before midnight.

Date	Star's Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Reappearance. Mean Time	Angle from N. point	Angle from Vertex.
			p.m.			p.m.		
Mar 1	f Tauri	4·3	6.14	121	101	7.9	205	176°
,, 2	γ Tauri	3·9	6.41	116	96	7.45	218	190°
,, 2	θ′ Tauri	3·9	11.51	114	74	12.40	235°	198°
,, 6	g Geminorum ..	5·1	5.47	15	51	6.3	349	24°

THE PLANETS.—Mercury (Mar. 1, R.A. 23^h 16^m; Dec. S. 5° 56′. Mar. 31, R.A. 1^h 0^m; Dec. N. 10° 1′) is at greatest easterly elongation on the 18th, and should be looked for in the west shortly after sunset for a period of four or five days on either side of the date of elongation. Although the elongation is only 18½°, it is a favourable one on account of the large angle at which the planet sets to the horizon.

Venus (Mar. 1, R.A. 23^h 2^m; Dec. S. 7° 44′. Mar. 31, R.A. 1^h 19^m; Dec. N. 7° 21′) is an evening star in Aquarius, but not well placed for observation. Near the middle of the month the planet sets about half-an-hour after the Sun.

Mars (Mar. 1, R.A. 1^h 8^m; Dec. N. 7° 3′. Mar. 31, R.A. 2^h 30^m; Dec. N. 15° 4′) sets about 9.20 p.m. throughout the month, and may be observed shortly after Sunset looking west. The lustre of the planet is, however, feeble, as he is at a point in his orbit situated at a great distance from the earth.

Jupiter (Mar. 1, R.A. 3^h 47^m; Dec. N. 19° 18′; Mar. 31, R.A. 4^h 6^m; Dec. N. 20° 20′) continues to be a conspicuous object in the evening sky; about the middle of the month the planet sets shortly after midnight. The planet is now describing a direct or westerly path, and thus he appears to be moving away from his position near the Pleiades towards Aldebaran.

The equatorial diameter of the planet on the 15th is 37″·2, whilst the polar diameter is 2″·4 smaller.

The following table gives the satellite phenomena observable before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Mar				Mar				Mar			
3	I.	Oc. D.	10 58	11	I.	Tr. I.	10 5	20	I.	Sh. E.	9 58
4	I.	Tr. I.	8 7		I.	Sh. I.	11 20	21	I.	Ec. R.	7 16
	I.	Sh. I.	9 25	12	I.	Oc. D.	7 25	22	II.	Oc. D.	8 25
	I.	Tr. E.	10 21		III.	Tr. E.	8 31	23	III.	Ec. R.	7 25
	I.	Sh. E.	11 38		I.	Ec. R.	10 52	24	II.	Sh. E.	8 35
5	III.	Sh. I.	7 24	13	I.	Tr. E.	6 48	27	I.	Tr. I.	8 32
	I.	Ec. R.	8 56		I.	Sh. E.	8 2		I.	Sh. I.	9 40
	III.	Sh. E.	9 31	15	II.	Ec. R.	10 45	28	I.	Ec. R.	9 12
6	II.	Tr. I.	8 45	19	I.	Oc. D.	9 24	30	III.	Ec. D.	9 27
	II.	Sh. I.	11 21		III.	Tr. I.	10 34	31	II.	Sh. I.	8 32
	II.	Tr. E.	11 23	20	I.	Sh. I.	7 44		II.	Tr. E.	9 2
8	II.	Ec. R.	8 9		I.	Tr. E.	8 47				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Mar. 1, R.A. 22^h 33^m; Dec. S. 10° 45′. Mar. 31, R.A. 22^h 47^m; Dec. S. 9° 28′) is a morning Star rising about 6 a.m. near the middle of the month.

Uranus (Mar. 14, R.A. 18^h 35^m; Dec. S. 23° 29′) is not well placed for observation; the planet rises about 3 a.m. on the 15th.

Neptune (Mar. 14, R.A. 6^h 33^m; Dec. N. 22° 18′) is due south at 7.7 p.m. on the 14th. The planet is situated about 3° S. and 1¼° W. of the star ε Geminorum, but is difficult to identify among the numerous small stars in the neighbourhood.

METEOR SHOWERS:—

Date	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Mar. 1–4 .	11 4	+ 4°	τ Leonis	Slow; bright.
,, 14 . .	16 40	+54°	μ Draconis	Swift.
,, 24 .	10 44	+58°	β Ursæ Maj	Swift.

Minima of Algol occur on the 2nd at 8.7 p.m., 22nd at 9.50 p.m., and 25th at 6.39 p.m.

DOUBLE STARS.—γ Leonis, X.^{h} 15^m, N. 20° 19′, mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better.

The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis, XI.^{h} 19^m, N. 11° 5′, mags. 4½, 7½; separation 2″·5. A pretty double of different coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, magnitude 8·5, and easily seen in a 3 inch telescope.

α Canum Venat. (*Cor Caroli*), XII.^{h} 52^m, N. 38° 50′, mags. 2·5, 6·5, separation 20″; easy double, can be seen with moderately low powers, even in 2-inch telescopes.

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Astronomical Photography.

Hints to Amateurs Regarding Apparatus and Methods of Working.

By ALEXANDER SMITH.

In dealing with astronomical photography from a practical standpoint, it may be explained at the outset that there is no single optical appliance suitable for all classes of work. Small nebulæ and dense stellar clusters require a telescope of sufficient focal length to give an image on a sufficiently large scale to exhibit structure, or to resolve crowded clusters into their individual components. For example, a focal length of eight feet is insufficient to resolve the central portion of such objects as M. 13, the great cluster in Hercules, while a similar instrument, when applied to some of the small but well defined nebulæ in the constellation Virgo, gives an impression on the plate no larger than that of a single bright star. The result to be aimed at in dealing with such bodies is to secure as large a photographic image as possible, which necessitates focal length, and, in order to bring the exposure within reasonable limits, a correspondingly large aperture.

The reflector with its single optical surface, absorbing as it does a minimum of light and giving at the same time the requisite correction for chemical rays, has so far proved the most popular form of photographic telescope in the hands of both amateur and professional, and the best all-round results have probably been obtained with specula having a ratio of aperture to focal length of f 4 or f 5. It has been found that with the sensitive plates now in use a reflector having an angular aperture of f 4 will record the faintest stars visible in the largest telescopes with an exposure of about 1 hour 30 minutes. If it is desired, however, to obtain impressions of large diffused nebulosities, such, for example, as that outside the Pleiades group discovered by Professor Barnard in December, 1893, on a plate, which had received an exposure of 10 hours, or of the large encircling nebula in the constellation of Orion, also successfully photographed by the same astronomer, then the ordinary telescope on account of its small field is altogether useless, and recourse must be had to a lens of short focus, which not only gives the requisite wider angle, but at the same time greater rapidity. Dr. Max Wolf has shown that his 2¼ in. aplanatic doublet is five times more effective for the delineation of nebulæ than the 13 in. Henry photographic refractor. On the other hand, it was found to be 32 times its inferior in recording impressions of stars ("KNOWLEDGE," December 2, 1895, p. 280). With such lenses—and those of the Petzval and stigmatic types are more particularly referred to—much original work may still be done, and, as they can be readily and effectively mounted on small clock-driven equatorials—either reflector or refractor—their use comes within the scope of amateurs, who may be already provided with such equipments. With a doublet lens of the portrait type, having an effective aperture of from 2 to 6 inches, and a focal length corresponding to an angular aperture of from f 3 to f 5, exquisite photographs of extended nebulosities, wide clusters, or of regions of the Milky Way can be readily obtained. Such lenses are also highly suitable for securing records of large comets, or of stray meteors, which may happen to cross the region covered by the plate at the time an exposure is taking place.

In selecting a lens for any particular kind of work it has to be kept in view that for photographing large faint nebulous masses the duration of exposure necessary to bring out a certain amount of detail is very appreciably shorter with a small lens than with a large one, notwithstanding that their angular apertures may be precisely similar. This is due to the circumstance of the smaller lens presenting a greater amount of contrast, and it is to this factor that the duration of exposure largely depends.

With points of light such as a star the duration of exposure is determined by the *intensity* of the rays, and, consequently, the contrast between the field and the stellar image depends entirely on the angular aperture of the lens, and the larger this is correspondingly fainter stars come within its grasp for exposures of similar duration. Of course, if the exposure is sufficiently prolonged, a small lens would record as faint stars as the largest telescope, provided the light rays are of sufficient intensity to set up chemical action on the plate.

Put briefly, the smallest class of lens, say, from 1½ to 3 inches of aperture, is the most effective optical appliance for the delineation of diffused nebulosities such as those in Taurus or Orion already referred to, while they are also well adapted for securing meteor trails. The class of phenomena coming within the reach of lenses of from 3 to 6 inches aperture is very much wider, and embraces well-defined nebulous areas, open clusters, regions of the Milky Way, stellar charts, comets, &c. If only a single lens is available it should have as large a linear aperture as possible, and as large an angular aperture as is consistent with good definition. For all solar, lunar, and planetary work, for crowded stellar clusters, for small nebulæ and all well-defined objects of this class showing structure, recourse must be had to the telescope, which, as already indicated, should for purely photographic purposes have an angular aperture of about f 4 or f 5. The size of the image on the plate will determine whether the focal length of the instrument shows the object on a sufficiently large scale to bring out the detail aimed at.

In presenting to the amateur the following hints regarding apparatus and methods of working, it ought to be pointed out that these are for the most part merely explanatory of the writer's own experiments, as he has never seen any photographic appliances used for astronomical purposes, other than those in his own possession. Satisfactory results can doubtless be obtained by other methods, and an ingenious amateur possessed of a little mechanical skill will be able to construct appliances in the shape of accessories, or adapt those he may have already at hand, to meet his individual requirements.

Mounting Cameras and Lenses.

To bring such lenses as those referred to into use they should be attached in the usual way to a suitable camera—preferably one of the old-fashioned box type, which secures the maximum amount of rigidity. If the lens is not fitted with rack and pinion the body of the camera should be made in two portions so that one part may be slipped, telescope fashion, into the other. When the solar focus of the lens has been determined previous to mounting a movement of about half an inch will be quite ample. The camera should be firmly bolted to the top of the telescope tube opposite the Declination axis, a position which least disturbs the balance of the instrument, and where any slight irregularities in the driving are reduced to a minimum.

With heavy lenses it is necessary that the mount be rigidly supported, otherwise the effect of flexure may, when the exposure extends to several hours, be apparent in the shapes of the star discs. A method which is found to be very satisfactory in practice is to place over the mount a flexible steel spring or strap tightly stretched by a screw to the camera base, which is extended below the lens for that purpose.

The circular caps, with which lenses are usually fitted when sent out by the makers, will be found with large apertures to be exceedingly awkward to manipulate in the dark, and are otherwise unsatisfactory. A simple arrangement, which leaves nothing to be desired, consists of a mahogany frame with shutter hinged to open like a door. If the hinges are placed at the side the shutter may be instantly closed with a piece of string, but, on the whole, it is, perhaps, preferable to have the hinges below, and the shutter to open from the top.

Fig. 1 shows a doublet lens of 5½ inches aperture and 22 inches focus, mounted on a Newtonian reflector with the appliances referred to placed in position. It may be here incidentally pointed out that this is the only form of telescope which the writer has had in actual use in connection with photographic operations, and certain of the accessories described and methods of using such are only applicable to this type of instrument.

Having decided to give an exposure of, say, two or three hours, on a particular object, it will not infrequently happen in this changeable climate of ours that before the desired limit has been reached operations may be stopped by cloud, and provision must consequently be made for completing the exposure on one or more subsequent dates. The risk of disturbing the position of the objects on the plate is thus considerably increased, and one of the most frequent sources of trouble in this respect is due to replacing the shutter of the dark slide. This may be obviated by attaching a stout bar to the back of the camera, and if two screws provided with cushions at the ends are passed through this bar so as to press firmly against the dark slide, no

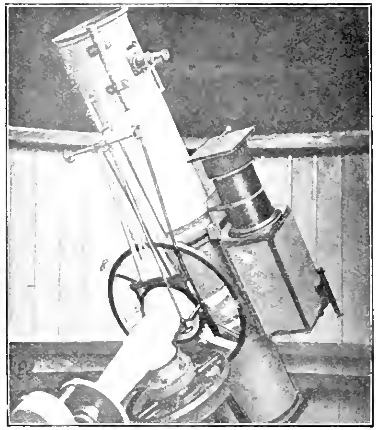


Fig. 1.

movement of the plate can take place. This arrangement is shown in Fig. 2.

Instances will occasionally arise where it is advantageous to have a number of short exposures of an object on the same plate. This is most easily done by moving the dark slide, and, in order to secure uniformity

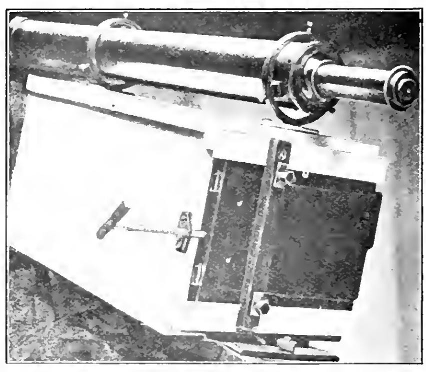


Fig. 2.

in making the necessary movement, a long screw (also shown in Fig. 2) may be attached to the side of the camera. The end of this screw presses against the slide, and by giving the requisite number of turns to suit the requirements of the object, a row of images is secured with exactly the same interval between each exposure. If a lens of long focus is used a very interesting series of photographs might be taken in this manner during the progress of a solar or lunar eclipse,

Guiding Telescopes.

In carrying on photographic work with lenses thus mounted the supporting telescope can always be used for guiding purposes, the best form of eye-piece being one of low power, fitted with cross wires sufficiently coarse to be readily seen on an out-of-focus image of a star. If the guiding telescope is of fairly large aperture, it will be found in practice that a star sufficiently bright can usually be found not very far from the centre of the field covered by the plate in the camera. The out-of-focus image of a faint star does not admit of being enlarged to the same extent as that of a bright one, and the cross wires should always be distinctly seen, otherwise guiding, particularly if the driving clock is not to be relied on, becomes a very tedious operation. The eye-piece should be turned until one of the cross wires exactly coincides with the path of a star across the field when the telescope is stationary, so that, apart from occasional slight alterations in Declination to correct for varying refraction, the movement of the telescope in Right Ascension will only have to be attended to, and any irregularity in the driving can be instantly corrected.

Focussing.

No difficulty need be experienced in adjusting the camera to the correct focus of the lens, if the sun be utilised for this purpose, and, when the position of the screen is such that the solar image is most sharply defined, this may for all practical purposes be accepted as the correct focus for all celestial objects. When the camera has been properly adjusted, and when this has been verified by a few exposures, the two portions of the box may be screwed together, as too much care cannot be exercised with the view of eliminating every possible source of movement which would be likely to disturb the register of the plate. If a screen of ground glass is used for focussing purposes it should be of the finest grade procurable. Perhaps a more suitable material is an ordinary gelatine plate, which has been exposed for a few seconds to a diffused light, and afterwards developed, fixed, and washed in the usual manner. Some have recommended a piece of plain glass with lines ruled upon it with a diamond.

Defining Properties of Lenses.

When the first exposure has been made a feeling of disappointment may be experienced when it is seen that the star discs are only sharply defined over a small central portion of the plate, while towards the edges they have the appearance of short circular trails. It must, however, be kept in view that the area of critical definition with even the best portrait lenses, when used without diaphragms, is usually smaller than the working aperture, and if a 5 in. lens covers a quarter plate sharply up to the edges, it may be regarded as having excellent defining qualities. With the view of getting good definition over a larger portion of the plate some have suggested a method known as "averaging the focus," *i.e.*, adjusting the focus to an object some distance from the centre of the screen. A few experiments carried out in this direction will, however, clearly show that the method is not one to be recommended, as it will then be found that the fainter stars at the centre of the plate, instead of being minute points, are blurred and enlarged. This applies with even greater force to photographs taken at the primary focus of a mirror, as the least alteration of the distance separating the speculum and plate appreciably alters the definition of the whole field.

(To be continued.)

Magnetism and the Corona.

Dr. Trowbridge's Experiments.

In the course of an investigation made by Dr. John Trowbridge, and reported by him in the *American Journal of Science*, on the phenomena presented by electric discharges in strong magnetic fields, he found that with high voltages and strong, steady currents, phenomena began to appear which were absent at lower voltages and lesser currents. For the purposes of the experiments, the description of which we are about to recapitulate, Dr. Trowbridge employed comparatively large tubes; and while the voltages ranged from 3,000 to 8,000 between the discharge terminals, the currents ranged from five milliampères to twenty milliampères. The cylindrical glass tubes containing rarefied air, which were used in the following experiments, were 30 centimetres long and four centimetres in diameter; and for resistances Dr. Trowbridge made use of a column of running tap water.

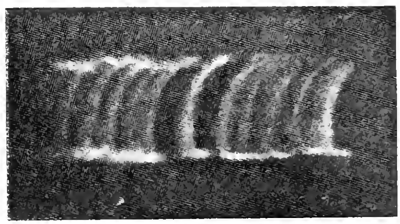


Fig. 1.

At pressures varying from 1 c.m. to 1 m.m., the cathode light on a circular aluminium plate, forming the pole of a powerful magnet, the magnetic lines of which were directed along the line of electric discharge, was driven to the circumference of the disc, forming to the eye an apparently steady circular discharge. When the tube was covered, however, with black paper, so that only the light on the disc could be seen, if this light were examined in a revolving mirror, an interesting case of unipolar rotation was seen. Fig. 1 is a photograph taken of the reflection in the revolving mirror.

The glass walls of the tube through which the photograph was taken and the necessary obliquity in the reflection caused by the mirror, modify the sharpness of the image. But the revolution of the image round the pole is apparent. The speed of revolution was found to increase with the degree of exhaustion of the rarefied air in the glass tube. Presumably when the free path of the ions increases, the progressive effect along the magnetic lines becomes more than the rotational effect of the magnetic field. When the plate formed the anode and also the end of a magnetic pole, so that the lines of magnetic force were directed along the line of electric discharge, the light at the anode was separated into two distinctly different lights, one (in rarefied air) a plume-like rosy light, the other a plume-like violet light. These discharges also revolved around the pole near the centre of the disc instead of on the circumference, as in the case of the cathode disc. On account of the number of individual discharges on the anode it was difficult to follow their motions in a revolving mirror, or by the eye, or to photograph them. It was certain, however, that they revolved about the pole.

Dr. Trowbridge draws the following inferences from the experiments :—

The unipolar rotation which I have described leads

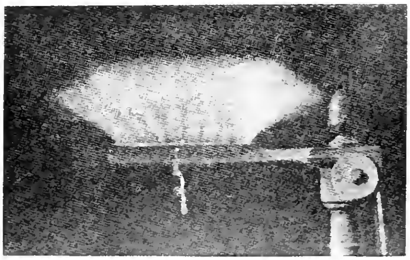


Fig. 2

my mind to connect the phenomenon of coronal streamers seen at the poles of the sun in an eclipse with the effect of a magnetic field on possible electrical discharges between the equatorial regions of the sun and the poles of the sun. If we suppose that a difference of electrical potential can arise between the swiftly moving strata of gases or from the eruptions which take place mainly along the equatorial belt and the polar regions, the supposed magnetic poles of the sun would undoubtedly tend to cause the resulting electric discharges to revolve about the pole. On account of the

Fig. 3.

vast circumferential area about the poles a number of discharges could occur at different points around the pole and each discharge would revolve under the effect of the pole. In observing the effect of a strong magnetic pole on plate terminals in wide tubes of rarefied air, at comparatively high pressure of air under conditions of high electromotive force and great current density, one can observe phenomena of rotation which cannot be photographed yet which present to the eye a strong analogy to the appearance of coronal streamers.

I arranged a number of collections of bristles on a disc which was then set in rapid rotation. Fig. 2 is a photograph of the appearance of such revolving streamers, which represent fairly well what may be seen at the terminal of a discharge tube in a magnetic field.

There is, however, another magnetic phenomenon which may have a bearing upon the coronal streamers at the poles of the sun. When the lines of magnetic force are at right angles, or transverse to the direction of the electric discharge, at comparatively high pressures, one to two centimetres, with currents from 5 to 20 centimetres, 3,000 to 8,000 volts in wide tube streamers radiate from the position of the magnetic pole.

Fig. 3 is a photograph of such streamers or stratifications. "It will be noted," says Dr. Trowbridge, "That these striæ make their appearance at a much higher pressure than that of the usual striæ in rarefied gases." Similarly, electric discharges around or towards the poles of the sun, transverse to the lines of magnetic poles of the sun, could be separated into streamers.

Mice and Pneumonia.

OF late years it has been confidently asserted by the bacteriologists that the domestic cat is the harbourer and the propagator of the germ influenza. An equally serious accusation is being made against the domestic mouse, which is said to be a probable disseminator of pneumonia. The bacillus which usually is held to produce pneumonia is, in one form, that of the pneumococcus bacillus, very generally with us; and it has been sometimes assumed that the reason why it is a more successful enemy of the human race in the winter months—December, January, February, and March—is the smaller resistance which we offer to it in this season of reduced vitality. That is a fairly sound hypothesis. Sir Lauder Brunton has shown, for example, that fowls, which are normally immune from pneumonia, can be made susceptible if they are kept standing long enough in cold water. But Dr. E. Palier, in the *New York Medical Record*, has another suggestion to offer. The common bacillus of pneumonia, for which he proposes the name of "diplo-lanceo-bacilli-cocci," becomes virulent only, he maintains, when it has attained a new vitality by passing through the system of an animal extremely susceptible to it. Such an animal is found in the mouse, and especially in young mice, which are very readily susceptible, and to which the disease usually proves fatal. These mice, which are especially plentiful in the winter months, and are more noticeable in the insides of houses, take up the pneumococcus of human beings, absorb it, and restore it in augmented numbers and more virulent form. In poorly ventilated rooms the virulent "d.l.b.c.", as Dr. Palier shortly terms the characteristic bacillus emanating from infected mice or from their decomposing bodies, become abundant. Dr. Palier claims for his theory that it appears a plausible explanation of the duration of pneumonia. Virulent "d.l.b.c." do not lose their virulence at once, but after the third or fourth generation. When the virulent "d.l.b.c." enters the human body, some seven or nine days elapse before they are reduced to comparative harmlessness. It is possible that other animals besides mice may act as temporary hosts.

Eolithic Man.

By W. A. Dutt.

Just now, when the Eolithic controversy is generating so much heat, and we are having, to some extent, a repetition of the arguments used for and against the authenticity of Palæolithic implements some sixty years ago, it may be worth while to look a little further afield than the Kentish Chalk Plateau and see how widely eoliths appear to be distributed over the surface of the earth, and what are the views of the chief authorities on these supposed implements of human fashioning in respect to their relation to the question of the antiquity of man. That we are enabled to do this with slight difficulty we owe chiefly to M. A. Rutot, the Curator of the Brussels Royal Museum of Natural History, and one of the most diligent investigators of Eolithic problems.

As long ago as 1867, the Abbé Bourgeois claimed to have discovered at Thenay (Loir et Cher), at the base of some freshwater beds, which are now referred to the Upper Oligocene, some flints which had been worked by human hands; and if the human fashioning of these stones could be admitted they would furnish evidence of the earliest appearance of man on the earth which has yet been suggested to us. On the subject of these Thenay flints, however, authorities disagree, and as recent researches in the locality have failed to reveal flints bearing any resemblance to those found by the Abbé Bourgeois, M. Rutot considers it advisable to leave the matter of Upper Oligocene man in suspense.

About the flints of Puy-Courny, near Aurillac, however, he has no doubt, and in considering them the earliest genuine eoliths he has the support of M. G. de Mortillet, Dr. Capitan, and several German anthropologists. These Puy-Courny flints were first found by M. J. B. Rames, in an Upper Miocene deposit, and their chipping is said to be remarkably clean and characteristic. So far they are the strongest evidence of the existence of Miocene man. As M. Rutot remarks*: "This industry being the most ancient known and admitted, it is to the Upper Miocene we must go for the first certain evidence of the existence of man." During the last two or three years a great number of eoliths have been met with in various localities of the Cantal Miocene, and a fine collection of them has been arranged and classified by M. Rutot for the Brussels Museum.

Next in order of antiquity, M. Rutot places the flints of the Kentish Chalk Plateau, which he refers to the Middle Pliocene, and describes as implements intended to break, scrape, smooth, and pierce.

Coming down to the Upper Pliocene, he claims as representing the eolithic industries of that period the flints discovered by the Abbé Bourgeois at St. Prest and those met with by Mr. Lewis Abbott in the Cromer Forest Bed. Geologists are uncertain, however, whether the implementiferous gravels of St. Prest belong to the Tertiary or the Quaternary period, and there seems to be a general opinion that it is safer to refer them to a period of transition between two distinct epochs. This is also the case with the deposits of the Cromer Forest Bed. So far very few supposed worked flints have been found in the Forest Bed; but M. Rutot, to whom these were submitted by Mr. Lewis Abbott, states that he had no difficulty in recognising them as eoliths.

The earliest Quaternary deposits containing eoliths are, according to the same authority, met with in the valley of the Lys (Flanders), in the valleys of the Escaut, Haine, Sambre, and Meuse, and on the plateau of the Campine. These early Quaternary implements are especially abundant around the village of Reutel, and M. Rutot has given the name of Reutelien to this particular eolithic industry. "The use of the flints," he writes, "dates from the beginning of Quaternary time, corresponding with the phase of the advance of the first Quaternary glacier." With the retreat of this glacier a new industry was developed, examples of which are found in the valleys of the Dendre, Haine, Sambre, and elsewhere. This industry is considered to be transitional between the Reutelien and a later one called Mesvinien, after a characteristic locality situated between Hyon-Ciply and Spiennes. This last-named is also unmistakably eolithic; but in certain localities the beds containing it are overlaid by deposits supplying transitional forms between the eolithic and early Palæolithic. The second transitional industry, which is known as that of Strepy, is naturally reckoned by M. Rutot as one of great interest and importance, as the localities in which it is met with not only provide implements in which eolithic forms are perfected, but also types which enable the archæologist to understand the origin of the well-known almond-shaped implement of the Palæolithic period.

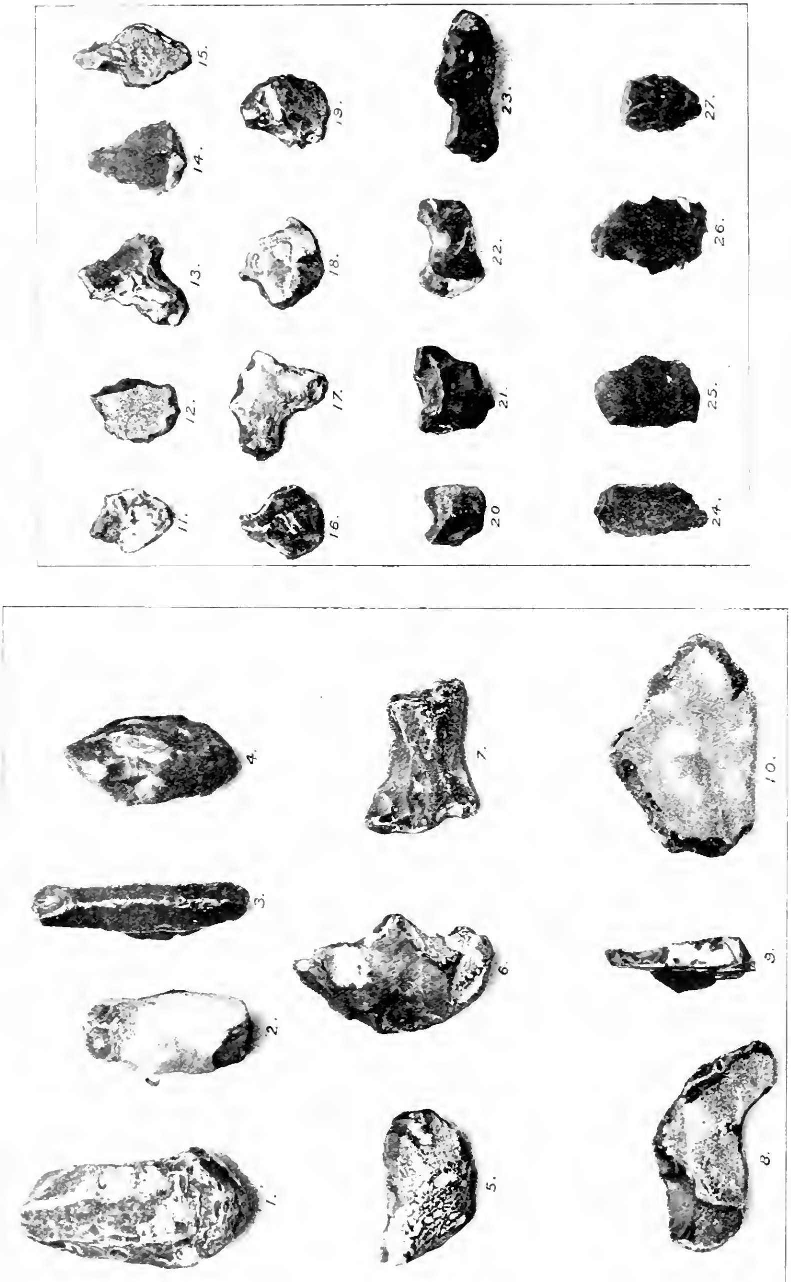
It may be mentioned in passing, that M. Rutot, after drawing attention to the fact that the primitive or eolithic period is characterised by an absolute stagnation—that is to say, the latest eolithic implements are no better nor worse fashioned than the earliest—advances an ingenious theory to explain the sudden advance in flint-working, noticeable in the period of transition between the Eolithic and the Palæolithic. This was due, he suggests, to a purely geological cause. In the Tertiary period, he says, an abundant supply of flints could be easily obtained by the men who had occasion to use them; but at the beginning of the Quaternary the flint beds were, to a large extent, covered by fluviatile deposits. As a result, men began to fight for the possession of the localities where flints could still be found, and this fighting led to the invention of implements which could be used as weapons of war.

In a paper printed in the Bulletin of the Brussels Anthropological Society, the distinguished Belgian savant expresses a belief that the investigation of eolithic problems now in progress must, in course of time, have valuable results, and he instances the discoveries of stone implements by Dr. G. Schweinfurth in Upper Pilocene deposits, in the neighbourhood of Thebes, and of similar implements by Dr. Klaatsch, in beds containing remains of the great marsupials (Diprotodon) of Queensland as evidence of the wide distribution of eoliths over the surface of the globe.

The accompanying photographs of flints of eolithic forms produced in the Cement Factory of Mantes must naturally arouse considerable doubt as to the human fashioning of many so-called eolithic implements; but it remains to be proved that natural causes can have effected such flaking and chipping as is done in a cement factory.

By the courtesy of the Secretary of the Anthropological Institute we are able to reproduce the photographs made by Dr. Hugo Obermaier, of Paris, of the flints of eolithic form which are accidentally produced in the process of making cement at Mantes, and Dr. Obermaier, in his paper, says: "I know no eolithic type which has not its correlative at Mantes. Specimens of large size are only absent because the bigger blocks and slabs are not put into the machine; but there occur cores, flakes, scrapers, and borers in a word all the eolithic types; and these are partly of rudimentary execution like the 'utilised' flints of the pre-palæo-

* Bulletin of the Belgian Society of Geology, Palæontology, and Hydrology, Vol. XVII. (pp. 425-438.)



Flints of Eolithic Form Produced in the Cement Factory at Mantes.

Reproduced, by permission, from "Man," the Journal of the Anthropological Institute.

lithic stage, partly of very complete development. Even the remarkably perfect pieces which are occasionally found among eoliths have their parallels at Mantes, where there occur scrapers, hollow scrapers (*lames à encoches*), and borers, which recall the finished types of La Madeleine. Bulbs of percussion, secondary chipping, and the other so-called criteria of intentional workmanship are all represented in their turn; and this is the more remarkable because the flint of Mantes is dry and hard of fracture. Were the softer flint of Puy Courny, for example, placed in the machine, we might expect modifications which differ from those appearing in the more refractory material obtained from the chalk.

"The process of manufacturing eoliths at Mantes is a rapid one. Recent experiments have shown me that they can be produced after a few hours of the rotary motion in water. When the tub is emptied after the lapse of twenty-nine hours the condition of the flints suggests the following sequence of events. Those first affected assume eolithic forms and are subsequently rolled and worn; at a later stage some of them are subjected to further shocks which give them the appearance of re-worked implements; in this condition they would resemble later (re-worked) eoliths. In any case it is demonstrated that the cement tubs of Mantes produce eoliths which are astonishingly like those of geological formation. As I showed in my previous paper, the arrangement of the machine proves that the pseudo-eoliths are chipped, not by any part of the mechanism, but by the shock and pressure of one flint against another. The rapid action of the water resembles that of the Rhone, Rhine, and other rivers when in flood, while smaller streams would be still more impetuous. The pot-holes formed by rivers are known to every student of geology. Anyone who has ever studied the ancient gravels of the Seine or Somme and other rivers, will be readily convinced that their volume was once very different from that which we now see. To-day they can scarcely carry down pebbles of small size, but formerly they deposited strata of the coarsest gravel, containing rolled blocks exceeding a metre in diameter. All this presupposes a torrential river-action such as no longer exists in these regions at the present day, but was experimentally reproduced at Mantes."

Few people could readily say which of all animals was the most conservative, but an article by Dr. E. H. Sellard in the *Popular Science Monthly* enables us to award the palm to the cockroach. No insects are more abundant as fossils and none so widely distributed through the various formations as are the cockroaches. The domestic cockroach, as many of us are aware, has a predilection for the neighbourhood of the kitchen boiler. The reason for it is that throughout geological time it has delighted in moist places. They are often found near the traces of streams; usually embedded among the remains of fossil ferns; and, indeed, persistent search among fossil leaves of land origin will hardly ever fail to bring to light at least detached wings and perhaps bodies of prehistoric cockroaches. It is an approximately complete geological record, an almost undamaged genealogical tree, which lends an especial interest to the cockroach family. Throughout their long existence they have retained, as compared with other insects, a relatively generalised structure. Morphologically they have learnt nothing, and have forgotten nothing. There have been one or two changes in their structure since Palæozoic days. Their heads became flattened; the upper part of their chests, the first thoracic segment, became rounded in the carboniferous era. The wings also began to change in the time of the coal measures, and the modern cockroach shows an alteration of the wing dating from Permian days and developing since. But except that the adventurous spirit and probably the fighting ability of the early days, as marked by stronger wings and bigger bodies, have decayed, the cockroach to-day is about exactly what it always has been.

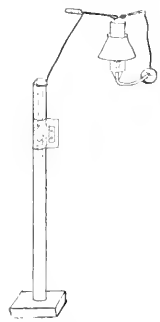
A Simple Gas-Lighter.

By Charles E. Benham.

The following simple device will be found very convenient for gas lighting, especially where incandescent mantles are used.

A celluloid tube—the tube of a cycle pump is exactly the thing, and at the cycle shops there are always worn out pumps to be had for a few pence—is fixed vertically in a wooden socket. At the upper end is inserted, so as to line the upper part of the tube, a wooden rod covered with tinfoil and about six inches in length. The rod is surmounted by a metal ball, which rests on the top of the celluloid tube. From the ball a thin wire is led to a thick iron wire projecting from the wall to a point centrally over the gas chimney. This iron wire must be insulated from the wall by a vulcanite or glass support. A second iron wire, uninsulated, also projects from the wall and terminates at a point about one-tenth of an inch from the first.

A strip of celluloid—such as a photographic celluloid film with the gelatine removed—clasps the celluloid tube by means of two little strips of wood, glued to it



A Simple Gas-Lighter.

as shown, and screwed together when the encircling film has been drawn tight round the tube. The film so forms a rubber which, when held by the wooden strips, can be passed up and down the celluloid tube. At every movement up and down of the rubber, sparks fly between the terminals, and the gas lights instantly. The finger and thumb should nip the rubber in the centre so that it presses close to the tube. The arrangement is not materially affected by atmospheric conditions. A curious feature of the device, and one which at first sight appears to be unorthodox, is the circumstance that the rubber and the electric to be excited are both of the same material, instead of being of different materials as is usually the case with friction machines. A rubber of flannel or silk may, however, be used instead of the celluloid film.

The mounted celluloid tube can be affixed either vertically on a shelf below the gas bracket or projecting horizontally from the wall, as may be the more convenient arrangement.

The terminals should not be pointed, but should be formed by loops at the ends of the thick wires, which are to be adjusted so that the spark is about an inch above the top of the gas chimney. The tube should preferably be of white celluloid. Using a larger celluloid tube a Geissler tube may be beautifully illuminated by connecting it with the brass ball.

The Coloration of Mammals and Birds.

By J. Lewis Bonhote, M.A., F.L.S., F.Z.S., M.B.O.U., &c.

(*Continued from page 373.*)

So far, our remarks have been restricted to those "poecilomeres" which were first to be noticed as "centres of bleaching" in Ratufa, but a closer examination will show that, in addition to those already mentioned, several other spots are to be noted.

Although in the present state of our knowledge we cannot show these to be actually "bleaching centres" in any particular species, yet they correspond so closely with those "poecilomeres" already mentioned that there can be no doubt that they arise in a similar manner.

The complete list of "poecilomeres" is, therefore, as follows:—

On the head, we have the nose, lips, chin, crown, occiput, ears, and the eye. This last has, in reality, two spots, the one in front of and above the eye (supraorbital), and the other below and behind it (postorbital). The white-eared cob (*Cobus maria*) gives us a good example of the eye spots.

On the upper part of the body we have the shoulders, thighs, rump, tip of the tail, wrists, and ankles.

The underparts are, as a rule, more uniform in colour, but where any tendency to diversity is shown we find it taking place along fixed lines, and the following spots may be noted as "poecilomeres, viz., the chin, inside of the arms and legs, fore-end of the sternum, and the vent or pubic regions. The best example of underside "poecilomeres" is to be found in a squirrel of South America (*S. dorsalis*), which is, as a rule, ochreous underneath, but shows in many individuals permanent white patches on most of the spots. In *S. pryeri*, a Chinese squirrel, the armpits and inside of the thighs and vent are rufous, while the rest of the underparts of the body are white.

Among birds the white ring of the ring ousel, the white breast of the female frigate bird, the red breast of the shell-duck, the violet patch of the jambu fruit pigeon, and the red patch of the blood-breasted pigeon, are good examples of the sternal "poecilomere." The red vent of the woodpecker and white vent of the moorhen are examples of another patch.

As regards the face markings among birds, the common kingfisher affords a good example, showing us the white chin patch, the green malar stripe, corresponding to the lower lip in mammals, the dark mandibular stripe, the rufous supraorbital and postorbital, and white oral patch. To continue multiplying instances of these spots is unnecessary. Anyone interested in the subject has only to go through any collection of birds or mammals to find instances on all sides.

It has been further pointed out to me, and is, perhaps, not without its significance, that the spots in which hair is found in man are all to be found among these "poecilomeres."

Unfortunately I am not a physiologist, nor have I been able to find in any book* facts which would tend to throw light on the nutrition or otherwise of these particular spots, but there is little doubt that any practical physiologist, who could afford the time, might, by investigations carried on in this direction, add a considerable amount to our knowledge of the cause of the patterns and markings in animals.

Most of the warning and protective markings will be found situated on these "poecilomeres," but there is one point which I would wish to impress, namely, that these same markings will be found in hundreds of cases, where, unless they were looked for, they would pass unnoticed, being merely represented by differences in shade so slight that they cannot possibly be said to serve any purposes of protection, warning, or recognition, but, in my opinion, form additional evidence to show that the brighter and more conspicuous markings have a much deeper significance than that put forward by those who believe the theory of natural selection to be all sufficient.

As examples of this, I will notice two or three from among our local British birds. In the hen house sparrow, for instance, the rump is unspotted; the rump of the hen chaffinch is slightly greener than the rest of the back; the hen yellow-hammer shows the dark ear patch and light malar stripe and chin. The linnet shows the two eye patches. The young cuckoo will often show a few white feathers on the occiput or crown. The wryneck (*Junx torquilla*) shows faintly the beginnings of the chin or malar stripe in having the feathers of those parts, although resembling the rest in pattern, white instead of yellow, while the dark patch in front of the barn owl's eye and the yellowish tinge on the breast are further evidence that the smallest of these markings is no mere sport or accident, but the result of deep-seated physiological causes. Among our British mammals the white spot on the forehead sometimes found in the common hare may also be accounted for on the same lines of reasoning.

"Poecilomeres" also manifest themselves in some species in a transitory state. The stoat offers a good example, for when it commences to assume its white winter dress it does so along well-defined lines. The first spots to show white are the thighs, whence the white spreads down the hind limbs and along the sides, gradually encroaching more and more on the colour of the back. It then appears on the rump and shoulders, spreading down the tail from the former, and down the forelimbs and over the shoulders from the latter. The head remains coloured to the last, but when it begins to change, the lips, nose, and ears are the first to whiten, the white from the nose extending up between the eyes as far as the forehead, thus leaving the eyes, postorbital patch, and frontal patch the last to turn. In a lesser degree this may be observed in many mammals; the common hare, for instance, showing a tendency to lighten on the thighs on the approach of winter.

Among birds the following example has come under my notice recently, and, with further observation, doubtless instances might be indefinitely multiplied. During the past winter I have had under observation two young shovellers (*Spatula clypeata*) that, during the early months of the year, have been slowly assuming the metallic-coloured head of the adult. Both birds performed this process in the same manner. The first sign of the metallic plumage was observed on the postorbital and ear patches simultaneously; these two patches spread and joined together forming a metallic patch similar in range and definition to that found permanently in the male teal. The patch of

* I am not unmindful of Captain Barrett-Hamilton's paper (already referred to) where he is inclined to consider the white patches to be due either to the presence of subcutaneous fat or to the direct contact of bone with skin, but for the present I prefer to express no definite opinion on this point. Mr. Tylor has also some suggestive ideas on this point.

adult colour then spread across the head till the whole of the head with the exception of a patch across the front was deeply coloured, the bird now having its head marked similarly to the hen scaup (*Fuligula marila*). The final stage was completed by the colour spreading *backwards* from the beak to join the metallic colours that already existed.

This case is important for several reasons. Firstly from its analogy with the case of the stoat, where, although the reverse change was in process, yet the parts that in the shoveller were the first to become coloured were in the stoat the last to become white.*

Secondly, to find processes, whose *outward* effects are so transitory that they can be of no importance to the individual, practically identical in two animals as widely separated as a carnivorous mammal and an aquatic bird can only point to one conclusion, viz., that they must have some deep meaning in the internal economy of mammals and birds far transcending their external effect.

Another point to be noticed is that during the change the birds assumed the more or less characteristic markings of two other species of duck, thus hinting at the probable way in which such markings arose, and, lastly, the assumption of colour on the lines of the "poecilomeres," beginning with the postorbital and ear, and these two joining together and subsequently covering the crown and occiput, while, finally, instead of the colour gradually spreading forwards it started again from near the beak, that is to say on the lip and nose "poecilomeres," whence it covered the head, this, I think, shows that these "poecilomeres" have very real and definite areas, and that although the colour arising from one "poecilomere" may spread into an area usually fed, so to speak, from another one, yet these "poecilomeres" will always be the first or last patches to be affected.

It may perhaps be said that the above example is a solitary instance and mere coincidence, but this is not so. The hen tufted duck yearly assumes for a short time during the summer the white patch characteristic of the scaup.

The blackheaded gull assumes during the early months of the year the brown hood in a very similar manner. The two eye and ear patches show first; these at first tend to join across the head with the crown and occipital patches, forming two dark transverse crescents until, finally, the back of the head becomes brown, leaving the frontal patch the last to become coloured. A herring gull, when assuming the white head of summer, becomes white round the beak first of all, and when in the brown plumage of immaturity will first show signs of the white breast on the sternal patch. The black throat of the lapwing (*Vanellus*), worn in summer, first appears on the chin immediately behind the lower mandible, and gradually spreads over the neck until it joins the black collar, and in many cases in young birds, *e.g.*, the corncrake (*Crex*), the feathers composing the ear patch are the first to grow.

Lastly I have known a brambling (*F. montifringilla*) that, in assuming its black head by abrasion of the feather tips, first lost the brown tips of those feathers round the beak that formed the frontal patch before referred to. This forms additional evidence that abrasion takes place on lines similar to those controlling "bleaching," and that it is a process governed by internal conditions.

This paper deals with a subject of such vast proportions and is dependent on so many minute details that it may be well to sum up the results and arguments in a concise form.

SUMMARY.

The object of this paper has been to show, firstly, that the colour of a bird or mammal is primarily due to "activity of nutrition and function," which has been called "vigour," and that where conditions for a high state of "vigour" exist we shall find the majority of animals brightly coloured and *vice versâ*.

"Vigour" is dependent on two causes.

(1.) Climate, which contains two factors:—

(*a.*) Temperature.

(*b.*) Food.

(2.) Rise and fall of sexual activity.

In *Polar Regions*, where the two causes coincide closely, the changes are much more marked and violent.

In *Temperate Regions*, where the climate is sufficiently severe to affect the "vigour," but where, at the same time, there is a sufficiently long period of comparative plenty to prevent the sexual activity clashing with climate, the changes are less marked.

In *Tropical Regions* the first cause is practically removed, and any changes in colour are due to sexual causes, except in cases of temperate species which have spread into the south.

Now the individual "vigour" of various species and groups will differ, and one animal may be able to maintain a full vigour under conditions which would be impossible to another. This will account for animals, although Polar, becoming brightly coloured, *e.g.*, musk ox, raven, penguin, &c. It follows, therefore, that if they can maintain a full "vigour" in colder regions, they can either (1) maintain an equally full vigour in the tropics, or (2) in hotter climates their metabolism would become too active and they would die. Consequently, a dark-coloured animal, in Polar regions, must either be confined to Polar regions or be cosmopolitan, *e.g.*, musk ox, raven.

By a similar process of reasoning, bright-coloured tropical animals will be found extending northwards, probably becoming lighter, while white or light coloured tropical animals will be confined to the tropics, *e.g.*, tiger, and *Rhizomys sumatrensis*, the bamboo rat.

Seasonal change or migration is a necessity in Polar regions, and birds which migrate to the tropics assume much more gaudy colours while in hot climates, becoming dull when the moult takes place in the Arctic regions, *e.g.*, knot (*Tringa*).

In temperate regions seasonal change will be a constant feature, but the changes will not be so marked, *e.g.*, squirrel, deer, but when these animals reach torrid zones, the "seasonal change" will tend to persist for some time, gradually disappearing, or it may become a "breeding change," as *Sciurus caniceps*, *Cervus eldi*.

There is among mammals and birds a process known as "bleaching"; this, I attempt to show, is an *active* process, and not mere action of wind and weather.

I further show that *bleaching* always takes place along certain lines, starting and spreading in various degrees from certain centres, *e.g.*, lips, eyes, ears, crown of the head, occiput, shoulders, thighs, fore end of the sternum, vent, tip of tail. To these centres or spots the name "Poecilomeres" (spotted part) is given.

The second part of the paper is devoted to showing how these "poecilomeres" exist as either white or

* I am now able to add a third precisely similar method of change in the assumption of the eclipse plumage in a smew (see *Avicult. Mag.*, Feb., 1905.)

deeply-coloured patches throughout the majority of species of mammals and birds, sometimes as large and conspicuous patches, *e.g.*, hindquarters of the rabbit, rump of bullfinch, and at other times only distinguished from the surrounding parts by differences of shade so slight as to be incapable of serving any warning, protective, or other similar purpose.

It is then pointed out that in some cases the "poecilomeres" are only visible as transitory patches during the time an animal is undergoing a change of colour.

The head of the stoat and of a young shoveller drake are cited amongst others as examples of the change taking place along precisely similar lines, whence it is argued that as the outward effect is so slight and transitory, and as the process exists in two animals so widely separated, the fundamental cause must be a deep-seated physiological one.

We, therefore, claim to have shown that where conditions for high vigour exist the majority of the animals will be brightly coloured, and suggestions are made to account for the apparent exceptions to the rule, which suggestions are borne out by the distribution of the dark Polar and light tropical species.

We have also shown that shortly before a moult, in many animals, the colour of the pelage fades, beginning along certain definite areas, and from certain centres which I have called "poecilomeres," and that this bleaching is due to physiological causes.

Further, that "poecilomeres" may be found throughout the mammalian and avian series, as patches differing either in their intensity or lack of colour from the surrounding portions, in many cases conspicuous, and cited as examples of warning, protection, &c., or, again, as marks so slight as to be unnoticeable unless carefully looked for, or yet again, merely appearing as transitory patches during the growth of a new pelage or plumage. Hence it is argued that these patches, so universal, and in many cases so inconspicuous, must owe their inception to internal rather than external causes, and that we have here the basis of diversity of colour in coloration. If these facts then be accepted, both colour and coloration must be due to physiological causes.

The question of whether seasonal changes are produced by moult or by colour has purposely been entirely omitted as belonging to a side issue.

Natural selection and protective coloration have also been left out, not because we do not believe in the great part they play, but because, if our suggestion be near the truth, they are only able to make use of those colours or modify those markings which in the first place are supplied by "vigour."

Tuition by Correspondence.

The University Examination Postal Institution of 27, Southampton Street, Strand, publishes a series of handbooks which are specially and excellently adapted for Cambridge Higher Local Candidates. The series includes a guide to this examination, giving full details as to method of preparation, and advice as to text books, together with reprints of papers set at previous examinations. As each paper is printed on a separate perforated sheet, it can be used by schools for examination purposes. The papers are kept up-to-date by the insertion once a year of the latest papers. To the French and arithmetic papers full answers by F. Thomas, B.A., B.Sc., and W. H. Dines, B.A., F.R.S., are published in addition to the questions. Both the method and the subject matter of this valuable little series of handbooks are well arranged, and we can confidently recommend them to the perusal of candidates and students.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Uncorrected Lenses.—A week or two ago, the Photo-Club, of Paris, opened, in their rooms, an exhibition of photographs made by means of lenses uncorrected or only partially corrected for chromatic aberration, and it appears that in due time a collection of these prints will be shown in London by the Royal Photographic Society. Uncorrected lenses have been used, and used purposely on account of the character of the image that they give, for long enough, but the lenses that this collection illustrates the use of, have been recently designed by MM. L. de Pulligny, and C. Puyo, and are issued commercially by L. Turillon, of Paris, under the name of "Anachromatic" lenses. They may be employed in the form of single lenses, symmetrical doublets, or with a negative lens behind a positive, as in telephotographic combinations. So far as can be gathered, it appears that the effects of chromatic aberration are specifically valued, as giving what a perfect lens would render as a sharp line, in the form of a diffused line that is darkest down its centre and gradually becomes lighter as the distance from the core increases. In this way, detail is softened and fine detail is averaged down to a comparatively level tone. These desiderata will be appreciated by many artists who photograph only for the purpose of making "pictures."

Of course, such lenses must be of greater focal length for a given plate than the modern anastigmat or even its predecessors need to be, because of their inferior covering power. The aim of the optician is to improve definition and increase covering power, and quite rightly so, but if the pictorial worker does not want these improvements, he is a positive loser in having instruments that possess them. It is the photographer's ignorance of optical matters that leads him to imagine that the more costly a lens, the better it should serve his purpose. Whether it will do so or not depends entirely on what his purpose is, and wherein the special value of the lens consists. The greater focal length is generally a distinct advantage in pictorial work, and granting this, the need for costly lens systems does not exist, even when fully corrected lenses are required. Complete descriptions of the "Anachromatic" lenses are not to hand, and therefore the novelty of their construction, if they are in any way novel, cannot be now given.

Improvements in "Cooke" Lenses.—Mr. H. Dennis Taylor, of York, the inventor of the "Cooke" lenses that are so well-known to photographers, is still seeking to improve them and increase their usefulness. The three single lenses that constitute the ordinary Cooke objective cannot be separated into two complete parts of greater focal length like so many modern lenses that thus give in one instrument the choice of two, or, if not symmetrical, three focal lengths. Mr. Taylor has devised a means of obtaining this advantage by duplicating the usual system of three lenses, making such modifications as the new arrangement requires. The diaphragm has, of course, to be between the two systems, and to maintain the aperture for oblique rays the exterior lenses are slightly enlarged and brought nearer to the others. In such a complete objective the light has to pass through twelve surfaces of glass in contact with air. And in a modification described, in which there are eight separate lenses, there are sixteen such surfaces. At every surface of glass to air there is a loss of light due to reflection, and Mr. Taylor estimates this at about forty-eight per cent. of the incident light, when there are twelve glass surfaces. A part of this light is altogether lost, passing out of the lens in front, but a part goes in the other direction and contributes to the general useless light in the camera, which of course, tends to produce fog on the plate. Mr. Taylor seeks to remedy this defect and secure greater brilliancy of image, by tarnishing the polished surfaces of the lenses, using a solution of sulphuretted hydrogen, for example, until they assume a brownish-slate colour by reflection. He thus claims to get a rather more brilliant image with six or even eight lenses than with only three lenses normally polished. It is quite easy to understand how that such a procedure will reduce the amount of reflected light, but it is not so easy to see how it increases the image-forming transmitted light. It appears at first sight that the tarnishing will reduce both the reflected and the transmitted light because of its absorbing power, but Mr. Dennis Taylor is such an experienced and expert technical optician that, presumably, there is some fault in this simple view of the matter. It may be noted that these improvements in Cooke lenses are not yet practically available.

Clearing Intensified Negatives.—The character of the gradation of a negative is, or ought to be, one of its most valuable properties, and, as I have often said before, there is only one method of intensification that has been shown to preserve it, namely, the mercury and ferrous oxalate method. All the more usual processes and a great number of those suggested but rarely used, have been definitely shown to be uncertain and unproportional in their effects, and therefore to alter the gradation in uncontrollable ways. A minor drawback to the use of an oxalate when only hard water is available is the precipitation of calcium oxalate, some of which may attach itself to the surface of the gelatine. If kept clean, it disappears entirely on varnishing and is quite inert, but it may, if desired, be removed by merely placing the negative in weak hydrochloric acid until it has been dissolved away. The strength of the acid seems to matter very little; perhaps strong acid, with ten times its bulk of water, is a good average. The time required may vary up to a few minutes. I have seen celluloid films and plates of various kinds treated in this way with invariable success, and have not heard of any failure or accident. The risk of frilling seems to be practically negligible. Therefore there are three distinct ways of obviating the difficulty resulting from such a deposit:—(1.)—It may be prevented by the use of soft water before and after the application of the oxalate. (2.)—It may be removed by means of hydrochloric acid. (3.)—It may be neglected if the negative is to be varnished.

E. A. Wilson. We do not know of any more recent book on the determination of longitude by photographic means than the one you mention.

NOTES.

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Determination of Radial Motions by Objective Prisms.

Director E. C. Pickering has just issued a further circular (No. 110) dealing with the method adopted at the Harvard College Observatory for the determination of stellar motions in the line of sight. The photographs are obtained with the Draper Memorial telescopes used as prismatic cameras, with large objective prisms placed outside the object glasses. A photograph of all the stellar spectra included in the region covered by one plate having been obtained, the objective prism is then turned through 180°, and then a second exposure on the stellar spectra is given *on the same plate*. It is not necessary or advisable to use two plates, as was formerly recommended. When, owing to special circumstances it is more convenient to reverse the telescope, instead of turning the prism, the plate must in such cases be turned 180°. The corresponding spectra of each star in the two positions may be brought end to end, or in any desired order, by adjustment with a cross-wired eye-piece. If the method were perfect it would only be necessary then to measure the distance apart of the corresponding lines of each pair of spectra, and each star whose radial motion was known would serve to determine the constant distance apart of the lines; the differences in distance, converted into wave-lengths, would then give the required motion of the other stars. Since the motions of the sun and earth are the same for all, these will be eliminated.

The principal sources of error, such as those due to the distortion of the lens, and temperature corrections, are radial, and may be determined by using both co-ordinates of the lines in all the spectra. Any changes in the differential refraction may be reduced by turning the prism so that the spectra become horizontal instead of vertical.

To illustrate the method a sample plate of the Pleiades group is given. On the scale of the spectra given by the 11-inch Draper telescope the probable error in the determination of the motion would be ± 3.5 km. In another series obtained with the 8-inch Draper telescope, covering 10° square, the dispersion is about one-third of the former series, but as the scale is also about one-third, the definition is considerably better, and measures on these may have nearly the same degree of precision. Much fainter stars are shown on the latter plates, lines being clearly defined in stars of the eighth magnitude.

The Coming Total Solar Eclipse, January 13 14, 1907.

Of the six total eclipses which are computed to occur during the next six years, that of 1907 seems least uncertain to yield significant results, and in anticipation of this the local particulars for various stations on the track of that eclipse have been communicated to the *American Journal of Science* by D. Todd and R. H. Baker.

Following the eclipse of 1905, August 30, by an interval of seventeen months, the figure and type of the corona will doubtless have changed considerably, so that it is of the highest importance to photograph the solar surroundings at this opportunity. Fortunately the track is wholly on land, but a great part of the region is so remote and difficult of access, being in Mongolia and the Gobi Desert, that it could be occupied only by equipping tedious and expensive expeditions.

The western half of the eclipse track, however, traverses

Turkestan, a trans-Caspian area penetrated by the Imperial railways of Russia, and, for travellers from the West, can be readily reached by way of Naples, Constantinople, Black Sea, Tiflis, Caspian Sea, Bokhara and Samarkand, or the alternative route *via* Berlin, Warsaw, Moscow, Samara, Orenburg, and Tashkent. On this railway about two-thirds the way from Tashkent to Samarkand lies Jizak, which is only a few miles to the south of the eclipse central line. Other easily accessible stations near Jizak, are

Name of Station	Miles from Central Line.	Latitude North ° '	Longitude East from G'wich. ° '	Totality Begins. H. M. S.	Totality Ends. H. M. S.	Duration of Totality. M. S.	Sun's Altitude. ° '
				Local Mean Time.			
Turkestan—							
Chimbai ..	3S.	42 56	59 40	21 19 0·8	21 20 45·1	1 44·3	14 47
Jizak ..	13S.	40 8	67 48	21 59 58·4	22 1 55·2	1 56·8	21 34
Zaamin ..	15S.	39 56	68 26	22 3 19·5	22 5 17·7	1 58·2	22 4
Ura tiube .	2S	39 59	69 0	22 6 37·1	22 8 40·9	2 3·8	22 21
Nau ..	14N.	40 8	69 22	22 9 10·5	22 11 5·1	1 54·6	22 29
Sanku ..	12S.	39 15	73 13	22 18 40·6	22 20 55·0	2 8·4	24 9
East Turkestan—							
Tagharma Peak ..	2S.	38 30	74 32	22 39 10·3	22 41 18·2	2 7·9	26 27
Posgam .	8S.	38 15	77 19	22 54 21·4	22 56 30·2	2 17·8	27 50
Yarkand ..	4N.	38 25	77 21	22 54 37·4	22 56 54·5	2 17·1	27 41
— .	[illegible]N	38 12	79 54	23 10 1·0	23 12 21·0	2 20·0	..
Cherchen ..	3S.	38 2	85 33	23 44 50·8	23 47 12·6	2 21·8	3. 14
Mongolia—							
Tsair-osu ..	2N.	44 43	106 41	1 49 41·6	1 51 56·7	1 15·1	19 23

Zaamin, Nau, and Ura-tiube, all well within the belt of totality.

In order to indicate the exact circumstances of the eclipse throughout the length of its track, the local particulars have been calculated for the eleven stations shown above, and an extra possible station between Yarkand and Cherchen included from the British Nautical Almanac.

Stars Having Peculiar Spectra.

A further list of stars showing special features in their spectra have been detected by Mrs. Fleming during her examination of the Henry Draper Memorial photographs of stellar spectra obtained with the prismatic cameras. R. Cygni. A photograph of this variable star, taken with the 8-inch Draper telescope on November 19, 1890, shows the spectrum of this star to be class Md (Harvard Notation), having the hydrogen lines $H\gamma$ and $H\delta$ bright. On a later photograph obtained with the same instrument on December 7, 1904, the spectrum of this star appears to be of the fourth type, resembling class Na, and shows no trace of bright hydrogen lines.

D.M. + 21° 1609.—R.A. = 7h. 23.3m.; Decl. + 21° 7' (1900).—This object is in N.G.C. 2392, or identical with it. N.G.C. 2392 was found to have a continuous spectrum, with three bright lines, by Winlock and Peirce, on January 7, 1869, and was later found to be gaseous by d'Arrest. Photographs obtained with the 8-inch Draper telescope on November 21, 1900, and November 27, 1905, show no trace of the bright lines characteristic of gaseous nebulæ, but that the spectrum is of the fourth type. The images of the object on chart plates, however, are hazy, and the image on a photograph obtained with the Bruce telescope on April 16, 1904, shows distinct nebulosity, especially on the preceding and southern edges.

D.M. + 36° 3907.—R.A. = 20h. 5.8m.; Decl. = + 36° 33' (1900) magnitude = 5.5. The spectrum of this star in Cygnus was obtained on plates taken with the 11-inch Draper telescope on July 4 and November 4, 1905, and shows the hydrogen line $H\beta$ as a fine bright line centrally superposed on the dark line $H\beta$.

Device for Developing Corona Photographs

One of the great difficulties encountered in photographing the solar corona during total solar eclipses is caused by the very great range in intensity of the object; in most cases it is necessary to expose many different plates for carefully arranged times of graduated duration, so that we may obtain records of all parts, from the intense inner corona to the delicate tracery of the outer streamers. If a photograph exposed for any considerable time is developed normally the inner corona is generally so dense by the time the outer details are brought out that it is unprintable.

Numerous suggestions have been brought forward for getting over this difficulty, the most successful hitherto being that of Burckhalter, who arranged a carefully calculated series of rotating screens over his photographic plates during exposure, so that the outer regions received more than the inner parts. These were partly successful in that all parts of the corona could be obtained of printing density on the same negative, but the artificial lines produced by the occulting screens were objectionable. Recently a method has been proposed by Mr. T. Thorpe, which appears to give promise of success. Instead of developing the negative in the ordinary way, it may be mounted on a turntable, and centred so that the centre of the corona is coincident with the axis of rotation. Then by means of a small funnel or pipette mounted on a radial arm also working on the same centre as the plate, begin the development by allowing the developer to fall near the edges of the plate; afterwards gradually approach the stream of developer from the funnel towards the centre, restraining the developer also if found necessary, as it approaches the over-exposed parts of the inner corona. The centrifugal action due to the rotation of the photographic plate will, of course, prevent any of the developer getting nearer the centre than is desired.

BOTANICAL.

By G. MASSEE.

The Periodicity of Sexual Cells in Dictyota Dichotoma.

DICTYOTA is one of the red seaweeds not uncommon on our shores. In common with other members of the group, three kinds of plants possessing different functions concerned with reproduction are present. One set of plants produce antherozoids, or male fertilising bodies; a second batch produce oogonia, or female organs of reproduction; while a third lot of plants produce tetraspores, or asexual reproductive bodies. The antherozoids, which are motile or possessed of spontaneous movement, and the oogonia are respectively liberated at maturity into the water, when the antheroids approach and fertilise the oogonia. Professor Lloyd Williams describes in *The Annals of Botany* the important discovery that this liberation of the sexual organs is periodic. Several crops succeed each other during the summer months, and each crop from the period of its initiation, maturition, and discharge, occupies a fortnight. This periodicity is found to synchronise with the spring tides, and is expressed by the author as follows:—"So intimate is the relation between the tides and the crops of special cells, that a study of the tidal almanac for any locality will enable us to predict the actual days during August and September in any given year on which general liberation and fertilisation of gametes will occur, and even should exceptional conditions prevail, the resulting error will only be about a day earlier or later than the one predicted."

Several factors are more or less concerned in promoting this periodicity, among which are variations in the degree of aëration and of pressure; also differences of temperature and illumination; but the most important stimulus which favours the fortnightly development and liberation of a crop of antheridia and oogonia is the periodic change in the amount of light, as a direct result of the alternation of neap and spring tides.

Plants collected in October and kept growing for several months in a laboratory showed periodicity in the liberation of their sexual organs, and behaved in every way in exactly the same manner as if they had been in the sea. This evidence is considered to indicate that periodicity is a heriditary character.

No periodicity is manifested by those plants bearing tetraspores or asexually-produced reproductive bodies.

Dispersal of Seeds and its Bearing on the Geographical Distribution of Plants.

Dr. Ridley, of the Bontanic Gardens, Singapore, has been studying the rate of dispersal of seeds by wind. They are grouped under three heads—winged fruits and seeds; plumed fr s and seeds; "powder seed," or dust-like, as orchid seeds, fern spores, &c. Winged seeds or fruit is dispersed at the slowest rate, and is unable to cross a wide expanse of sea; the plumed type is well adapted for rapid transit over open country, but is checked by forest areas, whereas "powder-seed" is dispersed most rapidly and to the greatest distance.

The greatest observed distance travelled by the winged fruit of a forest tree, *Shorea leprosula*, was 100 yards. From this it is calculated that this plant could, under the most favourable circumstances, only spread 300 yards in 100 years, and that it would take one and a half million years to spread from the Malay Peninsula to the Philippines, supposing a land connection existed.

Smut.

Smut is the name used by farmers and gardeners to designate certain kinds of fungi belonging to the genus *Ustilago*, which form black powdery masses in the ears of oats, barley, wheat, and various other grasses; also in the anthers of some flowers, as *Scilla*, *Lychnis*, &c. In the case of oats infection can only be effected when the plant is in the youngest seedling stage. The fungus spores are dispersed by wind, and retain their vitality until the following spring, when they germinate on any decaying vegetable matter present in the soil, usually manure; the germ-tubes pierce the delicate tissue of the oat plant immediately after germination. After infection the mycelioma of the fungus grows up along with the oat plant, without producing any injurious effect, until the flowering stage, when the fungus enters the ovary and produces a black sooty mass of spores in place of the fruit. Maize, or Indian corn, it has for some time been known, can be infected at any point where very young tissue is present, but with this exception it has up to the present been considered that all other cereals could only be infected during the seedling stage, as described for the oat. Brefeld, a German botanist well-known for his many and important contributions towards the life-history of fungi, has recently been studying the smuts attacking cereals, and has proved by experiments that the smut spores of barley and wheat can only infect the plant through the flower. The spores alight on the stigma, where they germinate and penetrate the ovule, remaining there until the following season. When such infected seed is sown, the fungus grows up along with the plant, and eventually produces smut in place of grain in the ear.

In some instances the fungus spores are dispersed by wind, in others they are carried to the stigmas along with pollen by butterflies. In the case of aquatic grasses, the fungus spores are conveyed by water.

This discovery adds wheat and barley to the already considerable number of economic plants of primary importance, whose most destructive enemy in the form of a parasitic fungus, can be conveyed from one district or one country to another in the form of mycelium present in the seed, tuber, bulb, &c. In this condition detection is impossible, and the danger of introducing disease into a new district considerably augmented.

Mosses as Storers of Water.

Experiments conducted by A. Cserey show that some abundant kinds of mosses, as *Hypnum*, *Dicranum*, *Sphagnum*, &c., absorb about six times their own weight of water in less than a minute, and require seven days wherein to give it all up again. This function is probably of much service on steep slopes, where an excessive rainfall if not checked would prove very destructive, and, further, by slow liberation of water the humidity of the air is, to some extent, secured.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

A Physiological Test for Copper.

It has frequently been noticed that the leaves of plants that have been treated with a solution of copper sulphate show abnormal deposits of starch. This is evidently due to the poisonous action of the metal upon the enzyme diastase, which converts the starch of the plant cells into sugar, and it has been found by Herr Ewert that a minute trace of copper sulphate (0.000051 gramme) is sufficient to produce this paralysing effect upon diastase left in contact with a very dilute solution of starch. On this fact he has based a very delicate physiological test for traces of copper. A plant watered with a dilute solution of copper sulphate at once begins to deposit the starch, and the latter can easily be recognised by the characteristic blue coloration that it gives with iodine. The leaves of a plant thus treated give the reaction after about an hour and a half, whereas the leaves of a normal plant do not turn blue on treatment with iodine.

The Origin of Fusel Oil.

Fusel oil, long regarded as an objectionable waste product in the manufacture of spirit, has latterly become an important article of commerce, owing to its use as the basis of a solvent for guncotton, in the manufacture of smokeless powders, and for artificial fruit essences, and experiments have been made to find a means of obtaining it in larger quantity. The most important discovery in this direction is that made by Dr. Ehrlich, of Berlin, who finds that, contrary to the generally accepted view, fusel oil is formed, not by the action of certain bacteria upon sugar, but by the yeast itself acting upon nitrogenous compounds, such as the amido acids invariably present in decoctions of malt. It transforms these compounds into amyl alcohol (fusel oil), and ammonia, the latter being utilised in building up the protein of its own cells. Dr. Ehrlich also finds that it is possible so to arrange the relative proportions of yeast and sugar that any given amount of the amido acid (leucine) may be added to the fermenting liquid and converted into fusel oil, which may subsequently be separated from the main product (ordinary alcohol) of the fermentation. An abundant source of leucine is found in numerous bye-products rich in nitrogen, such as horn shavings and the waste liquors from the manufacture of glue, and this discovery of Dr. Ehrlich indicates the possibility of establishing an important branch of industry in connection with the manufacture of spirit.

Earth-Eaters and their "Food."

Eaters of earth have been known for centuries, and to this day are found in Guinea, Senegal, and New Caledonia, and in various parts of South America. The French naturalist, M. Courty, who recently explored the high tablelands of Bolivia, states that the Indians there are very fond of a paste of clay, which they mix with coca leaves; but as a rule the earth-eaters take the clay by itself in the form of little pellets dried in the sun or over a slow fire. It has been asserted by certain explorers that the particular earth eaten has really some nutritive value. Humboldt, for instance, writing in 1800, mentioned that the Indians on the banks of the Orinoco consumed as much as one and a half pound per day of earth, "qui paraît être nourissante." Two specimens of these earths exhibited in the last Paris Exhibition have recently been examined by M. Balland. One of them, from Gabon, was a light-grey powder, consisting of about 95 per cent. of silica, about 4 per cent. of iron oxide and alumina, 0.5 per cent. of water, and traces of magnesia, etc. The other specimen, from New Caledonia, was of a yellow colour, and contained about 98 per cent. of silica, 0.4 per cent. of magnesia, and 0.8 per cent. of water, with traces of sulphate but was free from iron, alumina, or lime. A New Caledonian product, analysed in 1801 by Vauquelin, contained 18 per cent. of iron oxide and 2 per cent. of copper, the remainder being chiefly silica and magnesia. It is thus evident that these earths have no value as food, and may even be injurious when containing copper, although it has been pointed out that they may have a negative value as a supplement to a diet devoid of woody fibre, *e.g.*, fish, their mechanical action aiding in the division of the food and thus indirectly promoting digestion.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The New President of the Geological Society.

SIR ARCHIBALD GEIKIE, whose recently published "Founders of Geology" we notice in another column, and who has already filled the Presidential chair of the Geological Society with distinction, has again been elected as President for the next two years, in place of Professor J. E. Marr, F.R.S., who retires.

Beneath the Earth's Crust.

The question which is being discussed elsewhere in this journal as to what is at the centre of the earth is of extreme interest to geologists, not solely on account of its bearing on the problem of underground heat, but indirectly as possibly affording some clue to the variations in climate in past geological times. Geologists at one time did not hesitate to ask that a change in the direction of the earth's axis should be admitted, in order to explain the existence of fossil tropical plants in what are now the frozen regions of North America, a fact now apparently equalled by similar discoveries in southern polar regions. Mr. De St. Dalmas' contribution in "KNOWLEDGE" has usefully brought to mind the great Halley's theory of a solid revolving nucleus, although in his day he could scarcely have realised the bearing which, if proved to be correct, it would have on future geological science. Not only are we still with absolutely no clue to the cause of the existence of a magnetic pole at all, but there is no satisfactory theory to account for fossil vegetable life bearing a tropical facies in parts now bordering on Arctic regions. Halley's theory that there is practically a solid nucleus is accepted by most people. But his theory that its axis is at an angle to that of the earth, that its poles are the points towards which the needle dips, and that the movements of the magnetic poles are caused by a swaying motion of its axis around our poles, are points which have entirely dropped out of consideration.

Refraction of Earthquake Shocks from the Centre Core of the Earth.

The question of the constitution of the interior of the earth, as revealed by earthquakes, has just been the subject of a paper by Mr. R. D. Oldham, F.G.S., which was read at Burlington House before the Geological Society. It is particularly interesting, in view of the discussion now going on in our columns. The distant record, he says, of a great earthquake exhibits three distinct phases, of which the third represents wave-motion which has travelled along the surface of the earth and is not dealt with in his paper, as it can give no information regarding the interior of the earth. The other two phases form the preliminary tremors, and it is shown that they represent the emergence of two distinct forms of wave-motion, which have been propagated through the earth. He thinks that the wave-paths emerging at the greater distances have entered a central core, in which the rate of transmission of the first-phase waves is reduced to about nine-tenths, and of the second-phase waves to about one-half, of the rate in the outer shell. The great reduction of rate in the case of the second-phase waves means great refraction.

Mr. Oldham's researches lead to the conclusion that, after the outermost crust of the earth is passed, there is no indication of any material or rapid change of physical condition, nor probably of chemical composition, until a depth of about six-tenths of the radius is reached; but that, below this, there is a rapid passage to matter which has very different physical properties, if not also differing in chemical constitution. Without advancing any hypothesis as to the nature of this difference, he points out that it will have to be reckoned with in any theory of the earth. In the discussion which followed, the President observed that there could be little doubt that we were on the eve of important additions to the data available for discussing the subject.

At a meeting of the Geological Society on February 21, Miss Ethel M. R. Wood's paper on "The Tarannon Series of Tarannon" was read, the discussion being contributed to by Miss Elles. Mr. G. E. Dibley exhibited a dental bone of *Coniosaurus crassidens* (Dixon) from the *Holaster-subglobosus* zone of the chalk of Burham, near Rochester.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Plumage of the Shoveller.

AT the last meeting of the Ornithological Club Mr. J. L. Bonhote exhibited a fine series of skins of shoveller ducks (*Spatula clypeata*), illustrating the fact that this species differed, so far as he knew, from all other ducks, in having an *intermediate* plumage between that of the "eclipse," the full breeding plumage.

Hitherto birds in this plumage had been regarded as immature birds, but the difference between these and the adults was shown unmistakably. Thus, in this intermediate plumage the head is much darker than in the "eclipse" dress, without metallic gloss, while the feathers of the chest were white, with dark brown bars and a buff margin. Young birds also assume this intermediate plumage in their first year, but they may always be distinguished by having the white feathers of the breast *spotted* instead of barred.

This peculiar dress succeeds the "eclipse" plumage in September, and is gradually replaced by the full breeding dress, which, however, is not completed until the end of March.

Hybrid Black Game.

At this same meeting Mr. W. P. Pycraft exhibited a remarkably fine male hybrid between black game and pheasant, which had been shot at Ringford, Kirkcudbrightshire.

In this specimen the character of the males of both species were about equally divided. The head, neck, and under parts were of a rich glossy black with green reflections, but the flank feathers showed traces of the mahogany red and black characteristic of the pheasant. The peculiar notched feathers of the neck and breast which obtain in the pheasant were wanting The scapulars resembled those of the young blackcock, but the coloration of the back differed from that of either parents. The tail was fan-shaped, mottled with fine markings of black and brown, and without bars. While the quill feathers were like those of the pheasant, the coverts, like the back, resembled those of neither of the parents. The rump feathers were rounded in shape, not pendant and discontinuous as in the pheasant. As in the pheasant, the space around the eye was bare, though the area was smaller than in the pure-bred bird. The beak was of a pronounced pheasant type, but the nostrils were feathered as in the blackcock. The legs were feathered for about one-third the way down, but the scaling below resembled that of the pheasant only in so far as the outside of the lower third of the tarso-metatarsus was concerned, the rest of the scales being hexagonal in shape; while the comb-like fringe along the toes was conspicuous by its absence.

It is believed that this bird represents only the seventh known instance of the cross.

Greenland Falcon in Antrim.

In the *Irish Naturalist* for March, Mr. Robert Patterson records the fact that a male Greenland Falcon (*Falco candicans*) was shot on the top of the mountain called the Knockagh, near Carrickfergus, on February 12 last. The last record of this species in Antrim was in 1865.

Bittern in S. Wales.

"G. W. V." writes to the *Field* (March 10) to say that when shooting in South Wales last month he put up a bittern, and shortly after found another dead, "which had evidently been shot." We join with him in his expressions of regret, and agree further that "It is possible that these two were a pair and might have remained to breed."

King Eider in Orkney.

Mr. H. W. Robinson records (*Field*, March 17) the fact that an adult female of the king eider (*Somateria spectabilis*) was shot off the west of Graemsay, Orkney, on February 21.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Resolving Power with Wide Slits.

IN the ordinary use of a diffraction grating or prism, it is found to be necessary to use a very narrow slit if two very close spectral lines are to be seen separate from one another; because each line as seen is simply an image of the slit employed. The grating is used with the light falling nearly normal to it; while a prism is usually set in the position of minimum deviation (*i.e.*, the position for which the incident and emergent rays make equal angles with the normals to incident and emergent face respectively).

Mr. Morris-Airey, in a paper in the *Philosophical Magazine* for March, shows that quite wide slits, or even no slit at all, can be employed without any sacrifice of resolving power, if the grating or prism be placed so that the light strikes it at nearly grazing incidence. Schuster had previously shown that the purity of a spectrum (which is a measure of the smallness of overlapping of images arising from different wave-lengths), is given by

$$\frac{1}{\text{Purity}} = \frac{(\delta\lambda)}{\lambda} = \frac{2\lambda + A\omega}{\lambda R}$$

where ($\delta\lambda$) is the smallest difference in wave-length which will give distinctly separable images. A is the angle subtended at the slit by the lens of the collimator; w is width of the slit; and R is the resolving power corresponding to an infinitely narrow slit.

Now, Morris-Airey points out that A should not refer really to the angle subtended by the collimator lens, because only part of the complete beam of light passing through this lens may fall upon the grating. The effective portion of the lens is that which corresponds to the width of beam received by the grating or prism, and this is very small when the grating is placed in a very oblique position. But as A becomes small, w may be proportionately increased without any loss of purity; and, in fact, slits half a centimetre wide may still allow separation of the two yellow lines of sodium with a 1300 line grating. Owing to the magnificent casts of Rowland's grating, made by Mr. Thorp, of Manchester, which are on the market, good gratings are much more common possessions than once they were. All who own any such grating can obtain much more power out of them than has commonly been thought. For it is clear that if the slit be not widened when the grating is placed obliquely, *greater* purity will be obtained. A limit to what can be gained in this way comes in owing to the great loss of light for great angles of incidence. But it would seem that it is only transmission spectra which will be affected in this way. For reflection spectra, the increased reflecting power is an additional advantage which will enable a narrower slit to be employed. Anyone who wishes to show spectra on a screen to an audience will find it an immense advantage to make use of the above facts. The present writer has just set up a Rowland reflection grating with a slit 2 cms. wide, and with the grating very oblique. The lines of the "Swan spectrum" stand out as quite narrow bands. The spectra obtained are so brilliant that 10 or 12 can easily be obtained. The increasing effect of overlapping as the order of spectrum increases is very instructive. After the first few, the remainder appear as a succession of reds and greens, very similar in general effect to the tints of Newton's rings of high order. Of course, in the case of metal gratings not much advantage is to be expected because at normal incidence the reflecting power is at least 90 per cent., but in the case of glass ones very considerable gain may be obtained in exhibiting the reflection spectra.

Secondary Spectra.

While discussing a diffraction grating it may be interesting to point out that, besides the spectra usually seen, theory shows that there are a large number of very much feebler ones between each pair of principal spectra. These are the secondary spectra. They must be distinguished from "ghosts," which arise simply from irregularity in the ruling of the grating. Their number between two principal maxima is very great practically the same as the total number of lines in the grating; thus there will be as many as 80,000 on a 14,000 line grating six inches wide. In practice, they are invisible, and it is usually asserted that this is to be expected when the number of lines is large. It is at any rate certain that when the number is small they are very visible. They may be obtained as follows: Cut four parallel slits in a piece of thin brass or aluminium sheet, each slit a millimetre wide and with an interval of 1 mm. between each. Now by means of a long focus lens focus a narrow and very bright source of light (suitably obtained by putting a very narrow slit in front of the condenser of a lantern, with the lens removed) upon the focal plane of an observing eye-piece, and interpose the four opening grating just in front of the lens so that the light can only pass through the four openings. Take care that the sides of the openings are parallel to the slit. On looking through the eye-piece, a diffraction pattern will be seen consisting, if a piece of red glass be interposed, of a central principal maximum (the direct image), followed by two feeble secondary maxima; then a second principal maximum (the "first order spectrum,"); then four feeble secondary; then another principal one (the "third order spectrum" the second order is absent in this case). Everything is repeated in the same way on the other side of the central image.

Now it is easily calculated that the relative intensity of any principal maximum and the secondary maximum next to it is not very much greater when there are 80,000 lines than what it is when there are only a few. The reason that they are not visible in practice is that even the principal ones are always comparatively feeble, so that their feeble satellites are beyond detection. If, however, the "direct image" formed by any grating be examined, the satellites are quite conspicuous. With a 20,000 line Rowland grating about six can easily be seen on each side of the direct image those of the six being more and more evanescent as they are more removed from the centre. This simple observation is sufficient to show that there is considerable agreement between theory and practice even in minor details, although an examination restricted to the lateral spectra seemed to indicate that there was some disagreement. This is by no means the only case in which a peculiarity in the effect seen is due simply to imperfection in our sensations of vision.

The Joule-Thomson Effect.

When a gas is forced through a porous plug, it is usually at a different temperature at the two sides of the plug. Considerable interest has centred round this fact, because it can be shown that if a gas were a perfect gas (*i.e.*, one satisfying accurately both Boyle's Law and Charles' Law) it should undergo no change in temperature in such an experiment. In reality, it is found that most gases cool at ordinary temperatures in passing through; hydrogen, however, is an exception, it gets slightly warmer.

Olszewski, some years ago, showed that when hydrogen is at a temperature of about 80 degrees C. below zero, it does not change temperature when forced through a plug. This temperature is known as the "inversion temperature," because, for temperatures below it, cooling takes place instead of heating.

It now appears, however, that most probably this point is not a unique one, and that it all depends upon the pressure of the gas as to what the inversion temperature will be. There is no direct determination except the one quoted above. But calculations based on equations of state, which fairly satisfactorily represent the observed connections between the pressure, volume, and temperature of a given mass of a gas when these change, are all unanimous in indicating that for each pressure of a gas there are two inversion temperatures (if any), but that above a certain pressure there will be none. The last statement is equivalent to asserting that if hydrogen be sufficiently compressed, it will undergo warming in passing through a porous plug, whatever its temperature may be. Further experiments are badly wanted on this subject; and if it should turn out that the above prognostications are not realised, it will merely show that the true equation connecting pressure, volume, and temperature, is not the one upon which the conclusions are based; and we have here, indeed, a most sensitive means of obtaining information about this equation.

ZOOLOGICAL.

By R. Lydekker.

A New British Fish.

Among British freshwater fishes few are of greater interest than the group represented by the Lochmaben vendace (*Coregonus vandesius*), the Irish pollan (*C. pollan*), and several other more or less closely allied forms, each confined to a single lake or group of lakes. All these fishes are members of the salmon tribe, and are near akin to a marine species; the latter fact indicating that they were at one time in all probability migratory, but have now become confined to the lakes they respectively inhabit. This isolation is doubtless the main factor which has led to the distinctness of the various species. A further illustration of this tendency to differentiation is afforded by the recent discovery (detailed in the February issue of the *Annals and Magazine of Natural History*) that the vendace of Derwentwater is distinct from, although nearly allied to, the Lochmaben species. In allusion to its slender build, it has been named *Coregonus gracilior*.

The White Winter Coat of Mammals.

Much ink has been spent in discussing the question as to whether animals like the stoat, which in high northern latitudes turn white in winter, do so by changing their coats, or by the bleaching of the hairs of the dark summer dress. It has been demonstrated that the senile whitening of human hair is due to the presence of phagocytes, which devour the pigment-bodies; and from microscopic observations recently made by the well-known French naturalist, Dr. E. Trouessart, it appears that much the same kind of action takes place in the hairs of mammals that turn white in winter. Cold, by some means or other, causes the pigment bodies to shift from the normal positions, and to transfer themselves to other layers of the hair, where they are attacked and devoured by phagocytes. The winter whitening of mammals is, therefore, precisely similar to the senile bleaching of human hair, no shift of the coat taking place. Under the influence of exposure to intense cold a small mammal has been observed to turn white in a single night, just as the human hair has been known to blanch suddenly under the influence of intense emotion, and in both cases extreme activity of the phagocytes is apparently the inducing cause. Dr. Trouessart's paper is published in the *Comptes-rendus* of the French Biological Society for February.

A Dwarf Elephant.

As the heart of Congo-land is the home of dwarf representatives of the human race, so, according to a German naturalist, it is the abode of a diminutive race of the African elephant, which probably does not exceed five feet in height. The interest of this dwarf elephant centres in its relation to the extinct pigmy species of Malta and Cyprus, whose teeth indicate that they were nearly allied to the African animal.

The Horns of the Wild Sheep.

It is a well-known fact that the horns of several species of wild sheep are always more or less damaged at the tips. This has been explained by some as due to the animals fighting, or to their raking up the snow and ground in search of food; the latter theory not accounting for the fact that it is only the horns of old rams which are thus damaged. In a recent issue of *Shields' Magazine* Captain C. E. Radclyffe offers the following explanation:—

"My own opinion is that the tips are worn down intentionally, and that this is done by rubbing the points of the horns against rocks. On inspection we find that the tips are worn away, as if rubbed with a coarse file, and are not broken off. If the latter were the case the remaining ends of the horns would be more split and fractured than they are." . . . It seems that when the horns attain a certain size and shape their points interfere with vision, and in some cases also with feeding; for occasionally they grow into such a shape that when the rams are grazing their points, unless reduced in length, would come into contact with the ground. Somewhat remarkable powers of reasoning are thus attributed by the author to wild sheep.

The editor is indebted to the author, Mr. C. O. Esterby, for a copy of a paper on the nervous system of the copepod crustaceans, recently issued by the University of California at Berkeley.

Papers Read.

At the meeting of the Zoological Society on February 6, Dr. J. W. Jenkinson read a paper on the Ungulate placenta, Mr. E. S. Russell described a new hydroid polyp, and Miss Ricardo a new horse-fly; while Mr. H. Schwann communicated notes on a collection of African mammals, and Mr. Lydekker described others collected by Major Powell-Cotton. The most important paper was, however, one by Mr. H. G. F. Spurrell on the modes of articulation of the vertebrate lower jaw. At the meeting of the same Society on February 20, Messrs. Doncaster and Raynor described experiments in breeding Lepidoptera, Mr. W. P. Pycraft read a paper on certain passerine birds, Messrs. Thomas and Schwann gave notes on African mammals, and Dr. B. Dean discussed the habits of the Australian lung-fish.

Protection of Birds.

It is pleasing to note in the annual report of the Society for the Protection of Birds, that some humane restrictive laws are having good results. For example, Lord Curzon's order in India prohibiting the export of plumage, an order which had the support of native religious sentiment in India, has considerably reduced the output, though Indian bird skins and feathers still offered at the London plumage sales show that the order is evaded. The stationing of watchers at Dungeness and on Lundy Island for the protection of sea birds has done good also; and peregrines and buzzards are now nesting on Lundy. The gannets of the Bass Rock are now secure from the guns of idiot trippers; and it is hoped that the St. Kilda wren will be rescued from threatened extinction by the Inverness order of last summer. On the other hand, the decrease of swallows is still unaccounted for, and there is little hope of saving goldfinches from the imprisonment in the cages of London slums and birdshops to which the Sunday birdcatcher dooms him, unless Sunday were made a close day. That the goldfinch and the kingfisher will recover their number if protected has been shown.

Messrs. Newton, scientific instrument makers, have taken into partnership Mr. Russell L. Wright (son of the late Mr. Lewis Wright, the author of "Light" "Optical Projection," &c.), who has been for some years their works manager and head of their electrical department.

New Dinosaurs.

There seems to be considerable rivalry between New York and Pittsburg, Pa., on the subject of the gigantic reptiles of the Mesozoic age. Hardly had the former town recovered from its ecstasy at the possession of what it fondly believed to be the "biggest reptile on record," in the person of the fine Brontosaurus, presented by Pierpont Morgan, than it learnt to its chagrin that Pittsburg was still leading by a head and about fifteen vertebræ—to be exact, by 17 feet 9 inches, thanks to Andrew Carnegie's Diplodocus, the plaster cast of whose skeleton we have all seen and admired at the South Kensington Museum. Why, we may ask parenthetically, do the Mesozoic reptiles exercise such fascination over American millionaires? Is this an instance of elective affinities? Honours, however, are now easy between the rival towns, for the latest addition to the American Museum of Natural History in New York is the fossil remains of a Tyrannosaurus, the largest carnivorous land animal yet discovered, and the most ferocious monster of the Reptile Age. He was nearly thirty feet shorter than the herbivorous Brontosaurus, but was in every way more formidable, and was distinguished from the other dinosaurs by his agility, his superior brain, and his massive structure. He had immense feet—four feet long by three feet wide—and his total length was thirty-nine feet, while some of his teeth measured as much as six inches.

The first bones of Tyrannosaurus Rex, to give him his full title, were brought to light as long ago as the summer of 1902, at Hell Creek, in the bad lands of Montana, which have proved a veritable graveyard of prehistoric animals. During the summer of 1905, a second expedition was dispatched to the same place and a number of additional bones were excavated from a sandstone as hard as granite. The discovery comprised so many representative portions of the skeleton of the great flesh-eating dinosaur that the general appearance of the animal can be described with some approach to accuracy. While we may lament the disappearance of the placid Brontosaurus or the fragile Diplodocus, we have every reason for congratulating ourselves that Tyrannosaurus Rex is not our contemporary. He was practically a biped, with an agile, bird-like manner of progression, the immense feet possessing three enormous toes projecting forward, and one extending backward—all furnished with huge tearing claws. The head is much larger than that of the Brontosaur, and the great teeth are serrated and sharp-edged. Tyrannosaurus seems to have come in about the time that Brontosaurus went out—perhaps he materially hastened the departure of the latter. When these monsters roamed the earth, Montana possessed a sub-tropical climate, not unlike that of the West Indies to-day, the region including great seas of salt or brackish water, the sedimentary remains of which form the "bad lands" of our day.

A curious point with regard to the recently discovered plesiosaurian remains in Western Kansas, was the reason for the large pebbles found in the neighbourhood of the extinct reptiles. These huge pebbles were found inside the remains of the fossilised plesiosaurs, and it was alternatively suggested that the extinct monster swallowed them as birds swallow small stones to aid the gizzard in the processes of digestion, or that the animal may have had some idea of increasing its specific gravity by adding stones to its weight in order to sink to the level of the mud bottom where its food was found. It will be observed that doubt and even ridicule have been thrown upon the supposed bird-like digestive habits of these creatures. But according to Professor S. W. Williston, the cumulative testimony of writers both on this and the other side of the Atlantic is quite conclusive. It has been assumed that the plesiosaurs could not have utilised the pebbles as a means of digestion in a muscular stomach. But the modern crocodiles have a real, bird-like, and muscular gizzard; and it is believed that they have a similar habit. At any rate the habit has been imputed to them, and it is not stretching theory too far to believe that the plesiosaurs had similar muscular gizzard-like stomachs and originated the pebble-swallowing habit. The special plesiosaur with which the habit is associated is the *Elasmosaurus*, which of all animals either past or present had the longest neck recorded. It had no fewer than fifty-eight vertebræ in this portion of its frame, and its total length of neck may be modestly estimated at twenty-three feet. The length of its trunk was nine feet, of its tail eight feet—a great contrast to the *Diplodocus*. The extreme length of the largest-known specimen was probably sixty feet. As to the habits of these long-necked plesiosaurs in life, it seems most probable that they were general scavengers, usually living in shallow waters.

An Ancient Mazer: An Old Wassail Bowl.

By Barr-Brown.

A Mazer of great antiquity is now used as an alms dish in St. John's Church, Glastonbury. It is one of the most beautiful and ornate examples in existence. It has been described as a "brass or latyn-bowl." It is

Photo by W. Tully, Glastonbury.

An Ancient Latyn Dish.

circular in form and in diameter is sixteen and a half inches. The flat rim is two inches broad and its "depressed inside seven-eighths of an inch in depth." On the face of the rim are two borders a little indented one within the other. In the centre or bottom of the dish is a circular compartment, including an historical legend in bas relief of St. George and the Dragon. There is also King Ptolemy and his Queen, with Sabra, their beautiful daughter. On a thick rim is the ancient inscription:—"Ich Bart Geluk Alzeit; Bart Geluk Alzeit." "I brought good luck always."

The language is that of the Low Countries, which marks it as being of Flemish manufacture; the form of the lettering and the costume of the knight and his palfrey points to an antiquity as remote as the beginning of the 14th century. In the old almshouses founded by Edward VI. at Saffron Walden is preserved an ancient and very valuable wassail-bowl of brown wood with a silver rim, and a medallion in the centre with the Virgin and child engraved on silver. Its date is about 1400.

A New Oxide of Carbon.

By the action of the silent electric discharge on carbon monoxide, Brodie, in 1873, obtained a reddish-brown product which appeared to be an oxide of carbon; to this product the formula C_4O or C_5O_4 was assigned, analysis giving somewhat variable numbers.

Berthelot, in 1876, made similar observations and found also that the brown amorphous product which he obtained, gave, on heating, in addition to carbon monoxide and dioxide, a dark coloured substance having the composition C.O.

With the exception of these somewhat indefinite products, which have since received but little attention, chemists have up to the present time recognised only the two well-known oxides of carbon—the monoxide and dioxide.

It is, therefore, a matter of considerable interest to learn from Diels and Wolf (Ber. Deut. Chem. Ges. February, 1906, 689), that they have isolated, in a state of purity, a new and definite oxide of carbon having the formula C_3O_2. It is prepared by the action of phosphorus pentoxide in considerable excess on malonic ester, the change being represented by the relation:—$CH_2(COOC_2H_5)_2 = 2C_2H_4 + 2H_2O + C_3O_2$. This new oxide—carbon sub-oxide, the authors term it—is a colourless mobile liquid, which boils at 7°; it has an intensely pungent odour, somewhat resembling that of acrolein or of mustard oils, and burns with a sooty blue-edged flame. The composition was determined by combustion, and by explosion with oxygen and the molecular weight by vapour density determination.

When mixed with water, it dissolves immediately, forming malonic acid, and ammonia in ethereal solution converts it into malonamide. From these and other properties and from its mode of formation, it may be regarded as an anhydride of malonic acid, and the authors consider that its constitution is represented by the formula O : C : C : C : O.

By spontaneous decomposition, a dark-red amorphous substance is obtained, which dissolves in water, giving an intensely red solution.

H. J. H. FENTON.

ERRATUM. In the article by Mr. C. A. Mitchell last month on Poisonous Plants used for catching fish, the expression "natural order Derris" should be read as "genus," the latter expression having been used by a slip of the pen.

Thickness of the Earth's Crust.

By FRANK HARRIS.

THE persistent survival of gross popular fallacies long after their falsity has been clearly demonstrated, is one of the most gloomy features in man's intellectual outlook.

Some popular errors are, of course, much more reasonably excusable than others; to imagine the earth is fixed in space and devoid of motion is but to accord unthinking belief to the immediate evidence of our senses; and foolish only in that it fails to take into account the evidence presented by all except the most violently striking of celestial phenomena. Far otherwise is it with the popular belief that the earth consists of a globe of molten matter enclosed in a solid shell no thicker in proportion to its size than is the shell of a hen's egg to its contents; and that assumption of which this belief is the outcome, that the increase in temperature noticeable on penetrating the earth to trivial depths continues without limit towards the centre; for, not only can the first supposition be easily proved to be absolutely impossible, as can the fixity of the earth in space, but also is there no excuse whatever for the second assumption upon which the first is based; it is an utterly illogical conclusion from our premises.

If the earth contained any masses of dense fluid matter *very* great compared with the thickness of the enclosing shell, that shell, even if constantly repaired, would be utterly shattered twice in every twenty-four hours by the moon's tide-compelling action on the fluid mass.

If the earth had at any time consisted of a globe of matter all at one temperature, say 7,000° F., and the surface had been suddenly cooled down to its present temperature and so maintained, in one thousand million years the variation in temperature would be quite insensible at depths exceeding five or six hundred miles; and the variation near the surface—taking a reasonable co-efficient of conductivity—would be in 100,000,000 years very nearly what is now actually observed.

We need not, either, suppose the surface to be suddenly cooled as in the abstract problem. Rock is so poor a conductor of heat that as soon as the surface was solid, a few thousand years—at most say one million—would amply suffice to allow the actual surface to cool down to a temperature so near that now existing as to satisfy the supposed conditions.

There is, therefore, no reason whatever for supposing that the increase in temperature does not rapidly tend to a limit within a short distance of the earth's surface. It is easy to form an approximate idea of what this limiting temperature will be.

Supposing, for simplicity, that the earth consisted uniformly of granite; the limiting temperature would be just below that at which granite solidifies under the pressure to which it is there exposed.

It makes no difference in essential principle whether we suppose the earth originally to have consisted of a globe of molten granite—as might result upon condensation from a nebula or upon adequate collision between two approximately equal masses; or whether we suppose it originally consisted of a solid nucleus surrounded by an ocean of molten rock—as might have resulted from collision between one large and, possibly, sundry smaller masses; in either case it is easy to see what its future history would be.

Radiation taking place from the surface only would tend to rapidly lower its temperature there. Convection currents set up in the fluid hereby would constantly maintain an approximately equal temperature throughout the fluid mass; for in a fluid which is of low conductivity the effect of conduction is utterly insignificant compared with that of convection. Thus it follows that the temperature would be lowered about uniformly throughout the fluid, so long as fluid existed, and when solidification began the whole would be at about the same temperature, and this temperature would be approximately maintained until the whole was (with the exception of pockets of more fusible matter) completely solidified, for in this case, of course, solidification would take place from the centre outwards.

Independently, however, of any assumptions we have here made and of any particular hypothesis, the fact to which we would draw attention is indisputable—there is no reason whatever for assuming that because the temperature increases with the depth it does not rapidly tend to a finite limit. This fact was clearly demonstrated by Thomson and Tait in their Natural Philosophy published a quarter of a century ago.

MR. EDWIN LITCHFIELD sends a short article on this subject. After some introductory remarks which have already been imbodied in our previous articles, he continues: "The deeper a mine is, the higher the temperature. Let one be sunk half a mile deep, and then, by gigantic labour, make the mine into a valley of ten miles radius—the heat would be gone. Standing on the Welsh or Irish coast, the ground is not hot; dive down into the Atlantic; the "Challenger" did not find the waters beneath to be hot (rather cool), and yet they were five miles nearer the centre of the earth. The cause of heat in mines is from pressure of the 40 odd miles of air above, we sink out of our element, and, I suppose, let the air down out of its; and possibly the gases in the earth exude, and, pressed down by the air above, produce heat.

This is fact. Cold air from the mountains in Switzerland, passing above the valleys, and the sun's rays penetrating the cold particles, cause the undue heat in the valleys. In Melbourne, the cold wind from the South Antarctic blowing above the warm air from the North and not letting it rise, causes the burning-hot wind which lasts till the cold becomes the master. Often in this island we find cold weather follows unusual warm days, from the same cause.

Were a mine to be sunk through carboniferous rock, and another of even depth, through chalk, the former would be much hotter than the latter. It is also out of all conception that the crust of the earth in cooling could bottle up and enclose 7,000 miles diameter of intense heat. Should that amount of molten heat, or intensely hot gases be in the interior let us hope it never gets a vent—it would overwhelm the earth and sea.

We must raise some other idea to account for volcanoes and hot springs. I am not aware that the Laurentian, the first formed rock of our globe, so far as we yet know, shows sign of having been burnt, and deep borings have been sunk into Silurian rocks and yet the water comes up cold.

We might try and find some other reason why deep mines are warmer than the top of the Alps.

REVIEWS OF BOOKS.

Elements of Geology, by W. H. Norton Ginn and Co., the Athenaeum Press, Boston, U.S.A., pp. 440 and index; 6s. 6d.). There is scarcely a page in this book which has not its appropriate illustration or diagram, and to British geologists the many instances of geological phenomena drawn from the American Continent will prove of great interest and utility. Truly science is a strengthener of the amity of nations, and geology bids fair to bind still firmly together the inhabitants of the old and new worlds. We like the arrangement of this book. The stiffness of arrangement into various departments dynamical, structural, physiographic, historical has been abandoned, and as each geological process is reviewed, the land-forms and rock-structures which it has produced are treated in turn. The illustrations are, for the most part, small, but they have not suffered in the process of reduction. The various phenomena portrayed are clear and distinct, and excellent as is the advice that study in the field is absolutely necessary to the young geologist, it is not possible for any but a few to travel to the scenes which are here described. Accurate photographs are, consequently, of the greatest importance, and here we have a sure and safe guide. It is impossible to select any one portion of the book as more deserving of special notice than another. The Professor of Geology in Cornell University has done his work well, and we have much pleasure in calling attention to his book.—E. A. M.

Hints to Meteorological Observers (prepared under the direction of the Council of the Royal Meteorological Society, by William Marriott, F.R.Met. Soc., Assistant-Secretary. 6th edition revised and enlarged with illustrations, pp. 70 with frontispiece; 1s. 6d.) This valuable work is now brought up to date, and enlarged and provided with excellent illustrations, showing a great advance on the first edition of a quarter of a century ago. A comparison of the two will show the great advance made in meteorology during that period, as evidenced by a short list of some of the additions shown by a comparison between these two editions. Not having a copy of the intermediate editions, this is the only course open to us. This list includes such familiar subjects as Sunshine Recorders, Self-Recording Instruments, Kites, Phenological Observations, and Dines' Pressure-Tube Anemometer, showing that these are either new, or, at any rate, were too rare 25 years ago to be included in a handbook designed for the use of the ordinary meteorological observer. If there is one science which appeals to a large class as an interesting and by no means difficult or expensive way of increasing the world's knowledge, it would seem to be meteorology. The laborious night watches and heart-breaking conditions of "seeing," which press hardly on the astronomer, especially in later life, are almost unknown to the climatological observer, who, if his habits are regular and his health good, will find little difficulty in maintaining an unbroken and, therefore, valuable series of daily observations. To anyone looking for work of this kind we can confidently recommend Mr. Marriott's "Hints," which contain practically all he can want to know about instruments and their careful manipulation, with useful illustrations, tables, very much enlarged in the 6th edition for reduction and computation of various elements, conversion of scales, and so on, with a useful glossary of meteorological terms, and many other features, including as frontispiece the set of "cloud forms" with names and approximate altitudes (from Inwards' "Weather Lore"), and as tail-piece Dr. Jenner's well-known "Prognostics for Rain."

The Birds of Hampshire and the Isle of Wight, by the Rev. J. E. Kelsall, M.A., and Philip W. Munn (London: Witherby and Co., 1905). County histories of this kind do not, as a rule, form very interesting reading, while their usefulness is extremely limited. The present volume is, however, a notable exception to this rule; it may justly be claimed for it, indeed, that it is one of the best monographs of its kind that has yet appeared. And this because it contains something more than the mere record of species occurring, or extinct, within the limits of the county. On the contrary, its pages are richly stored with most interesting matter gleaned from the works of such celebrities as Gilbert

White, Col. Hawker, and Charles Kingsley; while the observations of others of the older but less famous residents in the county are often no less interesting. This is, notably, the case with the records which have been selected by the authors from the published works of Sir Richard Worsley, W. Gilpin, and J. R. Wise. We had imagined that nothing new of Gilbert White's now remained for publication, but this is not so, for the authors have succeeded in adding to this volume a certain amount of hitherto unpublished matter from MS. in the British Museum. The writers have included particulars of some 204 species, omitting such as are of doubtful occurrence, or have been introduced. Another feature of this book is the beauty of the illustrations, which have either been drawn by Mr. E. E. Lodge, or are reproduced from photographs; while the printing, paper, and binding show that the publisher is jealous of his reputation. W. P. P.

Cloud Studies, by Arthur W. Clayden (J. Murray, 12s. net). The study of cloud forms is certainly a most important subject, since it enables us to gain some idea of the meteorological conditions of the upper atmosphere, otherwise very difficult to obtain. Meteorologists are apt to rely almost entirely on the condition of the air within a very few feet of the ground, and to ignore that vast space of many miles high above our heads. Yet it is in the latter regions that rain and snow are formed, that the main winds prevail, often differing in strength and direction to those under-currents close to earth, and that temperatures may vary and precede changes on the ground level. By carefully observing the shapes and distribution of clouds much may be learnt of their conditions. The author of this book takes pains to classify cloud-shapes by the various names, and asks, "Is it not time that the international names were regarded as those of cloud genera, and to add specific names for those varieties which seem to imply some difference in kind?" It may be so, although it seems to us that clouds cannot be classified the same as beetles or orchids. There are too many cross-breeds, and entirely new species would often be observed, but never to occur again. Altitude is probably one of the principal factors in the variable appearance of clouds, and this, as the author points out, involves a complicated and difficult process of observation. The book is profusely illustrated with very good reproductions of photographs of clouds.

Marine Boilers. Based on the work by L. E. Bertin, translated and edited by Leslie S. Robertson. Second edition (John Murray, 21s. net).—The first edition of this important work, by the Director of Naval Construction to the French Navy, was issued in 1898, since which time much progress has been made. The most notable additions to the present volume are a chapter on Liquid Fuel, by Engineer-Lieutenant H. C. Austey, and the reports of th Admiralty Committee on Types of Boilers issued in 1900 and 1904.

Some Elements of the Universe. Hitherto Unexplained. Part II., by A. Balding. (King, Sell, and Olding, Ltd., pp. 32, 1s. 6d. net). Notwithstanding our unfavourable reception of Part I., the author sends us Part II., with an intimation that eight more parts are contemplated. Part I. was at least amusing, though perhaps unintentionally so. Part II. is almost entirely devoid even of this saving grace, consisting in great measure of scores and scores of diagrams illustrating the progressive motion of the moon's apside through a whole revolution. The effect is wearisome, and is not lightened by the harshness of the description. It is of course possible to find the L.C.M. of large numbers by trial, or to compute logarithms for oneself. We prefer the ordinary method, and even Mr. Balding does not venture to apply his alleged "discovery" to the correction of the moon's admittedly defective ephemeris, but simply gets his "computed places" from the Nautical Almanac. It would have been braver and more consistent to have gone further into the future. As to the alleged "discovery" to which we have before referred in connection with Part I., we wonder if Mr. Balding really imagines that when he is travelling the hands of his watch actually describe ellipses instead of circles. We would remind him that guarded abuse and thinly veiled sneers at the alleged short-comings of Newton and Laplace, as compared with Balding, are not argument, and that even if his notions were less obviously faulty, his attitude, which is not uncommon, tends to prejudice his case in the eyes of thinking men, who are inclined to ignore even strong arguments when presented with such questionable taste.

Last Words on Evolution, by Ernst Haeckel, translated by J. McCabe (London: A. Owen and Co., 1906, pp. 127, may be hoped most of us—do not accept Prof. Haeckel's illustrated; price 6s. net). Although many of us — it views on evolution and religion in their entirety, it is satisfactory to have a well-written and concise expression of these views in what we are told is to be their final form. In the preface the aged Professor states, indeed, that this will be his last address to the public; and in this respect it must have a special and in some degree a pathetic interest. For, however much we may differ from the more extreme portions of the author's views, none, we hope, will fail to admire a man who has been so true to his own opinions, and who has maintained them so consistently against all opposition, as has Prof. Haeckel. The present volume is practically a report of two lectures delivered by the author in Berlin in the spring of 1905, and contains a full summary of all his views on evolution. It is a pity that in some places the book is marred by careless editing, as on page 53, where we find the date of Lamarck's first work given as 1899. Würtzburg on one page and Würzburg on another is a second example of such carelessness.

The British Woodlice: A Monograph of the Terrestrial Isopod Crustacea Occurring in the British Isles. By W. M. Webb and C. Sillem. (London: Duckworth and Co., 1906, pp. x + 54, 15 plates. Price 6s. net).—Most of us who are not specialists on the subject (and these, we presume, must be few), will be surprised on taking up this beautifully turned-out little work, to learn what a number of species of woodlice and "pillmillepedes" are to be found in our islands. Up to the present time it appears that those desirous of making themselves acquainted with what is known with regard to British Woodlice, have had to consult a foreign work, and one which, by the way, is not easy of access. This is not as it should be, for if there is one thing British naturalists ought to insist upon, it is the publication of complete monographs of the whole of the British fauna. In having accomplished this work for the group in question, Messrs. Webb and Sillem deserve the sincere thanks of their fellow naturalists. Mr. Sillem, it appears, has drawn all the illustrations; and drawn them, too, in a manner it would be difficult to surpass.

Darwinism and the Problems of Life: A Study of Familiar Animal Life. By C. Guenther. Translated by J. McCabe. (London: A. Owen and Co., 1906, pp. 436. Price 12s. 6d. net).—That a book of this class should have, within a comparatively short period reached a third edition in its native country is, of itself, almost a sufficient reason why it should be translated into English. And when we come to consider matters more fully, there is ample reason for confirming this *primâ facie* view. As a matter of fact, there is no really trustworthy work on Darwinism—that is to say, natural selection—in this country, composed on thoroughly popular lines; and as Professor Guenther's book has been written for the express purpose of meeting such a want in Germany, there seems every reason to suppose that it has a place to fill in England. One feature we are especially glad to notice, to wit, the omission from the text of the names of authorities. Too many scientific books are hopelessly marred by the continual introduction of names of persons of whom the public know nothing, and for whom they care less. Of course, we do not agree with all Professor Guenther's views; but in the main he seems to have expressed himself fairly and judgmatically. We may also add a word of praise for the translator, although we rather wonder what animal he means by a "fitchet weasel"—maybe a polecat?

Experiences of a Naturalist in the Pacific, Between 1896 and 1899. Vol. II., Plant Dispersal. By H. B. Guppy (London: Macmillan and Co., Ltd., 1906, illustrated. Price 21s. net). So long ago as 1884, when surgeon on board H.M.S. *Lark*, in the Solomon Islands (when he had the good fortune to discover the second largest species of frog known), the author took an active interest in the modes by which islands and continents become stocked with their respective floras. And four years later, the same kind of investigation was continued on Keeling Atoll, and during a journey along the coast of Java. This, however, failed to satisfy his idea of thoroughness; and in consequence the years from 1890 to 1896 were largely devoted to a study of the constitution of the British flora from the standpoint of dispersal by water. But the completion of the work was accomplished during a second residence in the Pacific, from 1896 to 1899, when Dr. Guppy spent a large amount of time on Vansea Leva, in the Fiji group, the geology of which forms the subject of the predecessor to the present handsome volume. That the author is fully competent to discuss such a difficult subject as plant-dispersal, must accordingly be self-evident; and it is probable that he may be regarded as one of the greatest living authorities on this branch of botany. To follow his arguments is quite impossible within our limits; and it can only be mentioned that Dr. Guppy attaches prime importance to the buoyant character of seeds and fruits as a factor in plant-dispersal. So much so, indeed, is this the case, that if plants be divided into two groups, the one with buoyant, and the other with non-buoyant fruits or seeds, it will be found that nearly all the members of the former are concentrated near the coast. Insects, bats, and birds have, however, likewise had a large share in the dispersal of seeds. Although much of the work is necessarily technical, a large portion is very interesting reading; and the whole forms a mine of information on a fascinating subject.

Methodes de Calcul Graphique en usage a l'Observatoire Royal de Lisbonne. Par Frederico Oom (Lisbon Imprimerie Nationale, 1905; pp. 25, with four plates).—The Observatory of Lisbon is to be congratulated on the success with which it has facilitated a number of different calculations by the use of diagrams, and by the construction of special forms of slide rules. We are told that the methods here described are all due in the first instance to Vice-Admiral Campos Rodrigues, the director of the Observatory. Among the calculations performed by diagrams, we note the corrections for deviation and level error in observations with a transit circle, corrections for temperature, calculations of precession. In all these calculations, the ordinary "graphs" of our school courses would be insufficient, as the quantities involve several variables; the methods are, in fact, more analogous to those described by M. d'Ocagne, under the title of Nomography. The slide rules are still more interesting. One is used for conversion of solar into sidereal time, and conversely; another, in which the graduations represent reciprocals instead of logarithms (as on the ordinary scale), serves for calculations such as those connected with conjugate foci of a lens; another, graduated in squares, serves to find the sum of several squares, a calculation frequently required in the theory of errors, and so on.

On Models of Cubic Surfaces. By W. H. Blythe, M.A. (Cambridge University Press, 1905; pp. 106). Starting from the well-known property that a cubic surface has twenty-seven straight lines, real or imaginary, lying wholly on it, Mr. Blythe started some time ago to construct models of surfaces having these lines real. Finding, however, that such models had also been "made in Germany," the author has now collected in a handy form such properties and methods as are useful in obtaining information as to the forms and properties of cubic surfaces. There is no more fascinating study than the forms and classification of curves and surfaces, and the object of the investigations described in this book is to do for surfaces of the third degree what Newton did for curves of the third degree. But the most noteworthy feature of the book is that it can be read by anyone possessing a very limited knowledge of mathematics, and it can therefore be recommended for the interest of the subject to many readers for whom the majority of treatises on higher geometry are sealed books.

The Breeding Industry: Its Value to the Country, and its Needs. By W. Heape (Cambridge University Press, 1906; pp. xii + 154. Price 2s. 6d. net). For many years past Mr. Walter Heape has devoted himself with unremitting attention and energy to the study of all matters connected with the breeding of domesticated animals, and the many problems to which such a study must inevitably lead. His life's experience must be of the utmost value to breeders, and it is therefore highly satisfactory to have the results of his studies published in a concise form, and at a price which will make them easily accessible to all. That there was need for such a work cannot apparently be denied, for we are told that, despite the pre-eminence of this country in cattle and horse breeding, science has never yet taken her proper place in connection with breeding, if, indeed, she can be said to have had a status of any kind. Indeed, the author goes so far as to say that the breeding industry is the greatest industry to which scientific principles have never yet been applied, and that the nation which first applies science in this manner will reap solid advantage. May it be hoped that Mr. Heape's book will bring England first into the field in this new departure.

The Citizen: A study of the Individual and the Government. By Nathaniel Southgate Shaler (London: Constable and Co., 1905). This book, by N. S. Shaler, Professor of Geology in Harvard University, is written with the very laudable object of impressing on his readers, and especially Americans, the duty of taking an active part in the municipal and general government of their country. He commences by tracing the origin of mankind, and, as we would expect from a professor of geology who accepts the Darwinian hypothesis, the author goes on to trace the beginnings of government and then discusses the idea of liberty and the limits of freedom, the duties of citizenship, wealth, education, and civic government, religion, and the negro question. We consider the chapter on wealth contains sound advice to those who are inclined to extreme socialistic measures. On one point we would join issue with him. As regards the proposal to have a bodyguard to the President, he says, "It would establish a new principle that our magistrates are to be set apart from our people, and are not fellow citizens, to whom certain duties are for a time delegated. . . . Their risk is no greater than that of soldiers in time of war." We think that the position of President is more to be compared to that of a general, who does not needlessly expose himself to risk, as if he fall a campaign may miscarry. And as regards magistrates being set apart from the people, is not this necessary if the people are to respect the magistrates? We know the old proverb of familiarity breeding contempt, and there is no doubt that there is less respect for the courts of justice in America than in any civilised country.

MESSRS. JOHN WHELDON & CO.'s special catalogue of books and papers on Gardening and Horticulture has just been published, and is of great interest and value to botanists and horticulturists. The catalogue is especially strong in antique books on floriculture, and includes examples of the great Dutch horticulturist's works.

IN the new catalogues issued by Messrs. Isenthal and Co. the new mercury vapour lamps hold a prominent place. During the last few years the mercury vapour lamp, representing a much higher efficiency in the conversion of energy into light than is possible in the case of incandescent lamps or even of arc lamps, has passed out of the stage of a laboratory experiment into practical use. Messrs. Isenthal are now making them in three standard lengths of eighteen, twenty-six, and thirty-eight inches respectively, so as fully to utilise the varying standard voltages of from 100 to 250 volts. As the readers of "KNOWLEDGE" are well aware, the light from mercury vapour lamps is conspicuously free from red rays, and, being in appearance a bluish green light, imparts distinctive colours to all objects on which it falls. But it fatigues the eye very little, and, owing to the great diffusion of the rays arising from the length of the tubes in which the light glows, casts no hard shadows. It is, therefore, very useful for technical purposes, such, for example, as studio work, drawing, photochemical testing, or for therapeutic purposes. The richness of the light in ultra-violet rays lends to it specific purposes in other technical applications. Messrs. Isenthal include in their catalogue a number of new electric heating appliances to enable laboratories and factories to make use of the electric current for the purposes of chemical, metallurgical, and physical work to the fullest extent. These are often extremely ingenious, and show the increasing tendency to make use of electric energy for heating purposes.

MICROSCOPY

Conducted by F. Shillington Scales, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 392.)

The details of adjustment and focussing may now be recapitulated. The necessary centring adjustments have been carefully explained, and the image may be assumed to be projected and focussed upon the ground-glass screen. It is well now to examine it carefully to see that it is correctly in the centre of the screen, and that its size corresponds with the plate to be used. If a quarter plate is being used it is well to mark the limits of the plate in pencil on the ground glass. Particular care should be taken at this stage to note if the illumination is even all over the field; if not, the sub-stage condenser may need a slight re-adjustment by means of its centring screws. It is also well to make now the final adjustments of the iris diaphragm of the sub-stage condenser, bearing always in mind that the apparent sharpening of the image by closing the diaphragm is more apparent than real, and that any excess in reduction of aperture will give fuzzy diffraction effects in the photograph as well as prolong the exposure and increase any tendency to unequal illumination. Of course, the lower the numerical aperture of the objective, the smaller will be the cone of illumination that it will bear, but it is a fairly safe general principle to shut down the diaphragm cautiously and to stop as soon as, or very soon after, the image begins to show signs of reduction in brightness. All these adjustments can only be carried out on the ground glass screen. The plain glass screen is then put in place of the ground glass, and the image is now invisible until the previously adjusted focussing lens is laid lightly upon the former screen; through this the eye looks directly down the tube, the focussing lens performing as a positive ocular. The increase in light is so marked that it will be difficult to make any other adjustments than those for the final focussing,and for this purpose the focussing lens is moved about on the glass whilst one hand adjusts the fine adjustment of the microscope. It is then only necessary to close the camera shutter gently, replace the plain glass screen with the dark slide, and make the exposure.

The extension of the camera gives considerable latitude in magnification independent of any change in objective or ocular, and, of course, with any change of objective the sub-stage condenser will generally need re-centring. But unless the camera is fairly short it will be found impossible to keep the eye at the focussing lens and at the same time to reach the fine adjustment. It is, therefore, more than a convenience to have a light rod running along the camera with a milled head at one end and at the other a grooved pulley lying exactly in line with the milled head of the fine adjustment of the microscope, which is now nearly always itself grooved for this purpose, whilst between the two an endless cord passes. The focussing adjustments can then be made with ease at the very end of a long camera extension. This arrangement is better than any Hooke's jointed rod. Messrs. Watson and Sons have, however, largely done away with the necessity for both ground and plain glass screens (as well as focussing rod), by inserting in their place a sheet of highly glazed cardboard, which can be viewed directly from the inside by means of a small door cut in the side of the camera. The facilities this gives for ease of adjustment of all the centring movements is great, and when I say that the flagella on a bacillus like *Typhosus* can be readily focussed by this means it will be seen that it is amply sufficient for nearly all purposes. I may, perhaps, mention that I myself use this method almost exclusively. But, of course, a good condenser and a strong light, such as the arc light or the oxy-hydrogen jet, are necessary, and for this reason I have gone into so much detail on the older and more general methods of focussing, &c.

(*To be concluded.*)

Royal Microscopical Society.

At the meeting held on February 21, the President, Dr. D. H. Scott, F.R.S., in the chair, Mr. Waldron Griffiths described his method for mounting delicate vegetable tissues in xylol-balsam, and exhibited under microscopes some excellent specimens of *Pezıza*, *Spirogyra* in conjugation, and *Zygnema*. Mr. Beck exhibited and described an optical bench for microscope illumination, with ordinary or monochromatic light. Dr. Hebb exhibited a one-fifth inch objective, designed by Wenham in 1870, and made by Ross, to be used either as a dry or water-immersion lens. Mr. Walter Rosenhain described a new form of metallurgical microscope, the body of which is attached rigidly to a specially-designed limb carried on large trunnions, the stage moving up and down as is usual in metallurgical microscopes, and being provided with coarse and fine adjustments. Mr. Earland gave an abstract of a paper by Mr. W. P. Dollman on "A method of producing stereo-photomicrographs," and exhibited a number of exceedingly good stereoscopic prints in illustration of the paper. Mr. Taverner then read a short paper on "A simple method of taking stereo-photomicrographs, and of mounting the prints without cutting." The methods described in the two papers were quite different, and Mr. Dollman limits his operations to very low powers, giving amplifications of 9 to 20 diameters only. He uses a stop in front of the objective and exposes first one side of the lens and then the other, as he takes his two stereoscopic photographs. Mr Taverner uses higher powers, and a peculiar stop at the back of the objective. The authors adopt a similar arrangement for obviating the necessity of cutting the prints. Mr. Rousselet gave an abstract of a paper from the Hon. T. Kirkman, "A second list of Rotifers of Natal," in which a remarkable new species, *Copeus triangulatus*, was described.

Quekett Microscopical Club.

At the annual general meeting held on February 16, the President, Dr. E. J. Spitta in the chair, the annual report showed an increase in membership during the year, the number of members on December 31, 1905, being 402. The hon. treasurer's report on the financial state of the Club was also very satisfactory. Dr. E. J. Spitta, F.R.A.S., F.R.M.S., was re-elected president, all the other officers were also re-elected, with the exception that Dr. G. C. Karop becomes a vice-president in place of the late Mr. J. G. Waller. The president delivered the annual address, dealing with "The Relative Merits of the Short and Long Tube for Microscopes." The short-tube stand was probably introduced by Oberhäuser, certainly before 1857. It was not received with favour in this country as it was considered that too much work had to be done by the ocular in comparison with that required in the English form, that is, to obtain the same amplification. Consequent on the great improvements by Abbe in the construction of objectives, this objection cannot now be sustained, as a modern objective should stand such magnification by the ocular as will bring the total amplification up to one thousand times the N.A., without furnishing a "rotten" image. For ease of observation when the instrument is placed in a vertical position, as, for instance, when using fluid media on the stage, the advantage of the short-tube form is indisputable. In photomicrography the long-tube has some advantages, but the ideal instrument was considered to be a short-tube stand, which could be quickly converted to the long form, either tube length being available as required.

Cinematograph and Microscopy.

At a recent meeting of the Society of Arts, Mr. F. M. Duncan showed examples of the successful application of the cinematograph to microscopical investigation, illustrating the circulation and rotation of protoplasm, and the movement of the chlorophyll bodies within the cells of the leaf of *Elodea*; the circulation of the blood in the web of the frog's foot and in the tail of the goldfish. The lecturer also exhibited micro-bioscope pictures of *Hydra Viridis*, various birds, beasts, and reptiles in motion, and of the life and work of the wood ant.

Notes and Queries.

S. C. Mitra, Bombay.—The samples of wood sent you contain various woods, but you will find drawings in Hertzberg's book which will enable you to judge of this for yourself. The colours of the wood-pulps mean merely that one is treated so as to be of a whiter colour for paper-making and to need less bleaching. Some wood fibres polarize very well, others not at all—it is largely a matter of treatment in manufacture. A thin slice of raw deal, for instance, polarizes excellently. Polarized light often brings the structure out better, but not always—it is of course a question of refraction.

C. E. Garner, Shanghai.—I was glad to get your letter and wish you all success with your work. It must be very difficult to work so far from home, but I shall be very glad to help you in any way I can. You certainly have a good outfit and no lack of books of reference. You cannot do better than continue your entomological studies, and I should be most grateful for any insects you can send me, many of which would very probably be welcome in the University Museum here. The mere collecting of insects from your district for transmission home would be of much interest and use, with such additional study as you could give them. Do you ever get any mites? I know at least two people here to whom they would be of great interest.

W. H. M., Tunbridge Wells. The best monochromatic light is undoubtedly obtained with a prism and heliostat, but this has such palpable disadvantages that it is seldom used. The prism has recently been adapted for use with a Nernst electric lamp, and this gives very good results, but with any less powerful means of illumination the loss of light is too great. For all ordinary purposes, Mr. Gifford's new fluid screen fulfils every requirement. It consists of a slip of signal green glass immersed in a solution of malachite green in glycerine, and gives practically monochromatic light, though even here there is a marked loss of light when using immersion lenses. Mr. Gifford's simple little F line screen, which drops into the condenser mount is cheap and handy, but less perfect, and loses more light still. I have found the fluid screen fulfil every requirement.

"Arabian," Jerusalem. I do not consider that there is any difference in workmanship in the two microscopes you mention, in spite of the difference in price. You are, however, quite right in your criticisms as to the Continental form of fine adjustment, and though makers who used this adjustment for a long time argued stoutly that it was not unsatisfactory, they have now admitted it by fitting improved adjustments to their more expensive stands, such as you mention. These adjustments are a great improvement, but they are expensive. My advice would certainly be to have this improved fine adjustment if you have definitely decided to buy a Continental stand, but an English stand, if carefully selected, would be equally satisfactory in every way and would, contrary to the common idea, cost you less. Between the two immersion lenses you mention there is, in my opinion, nothing to choose. Both are excellent.

R. S. B. P., Streatham. Mr. Cole's method of mounting pollen is, after drying it, to soak it for some days in turpentine, and then to mount the cover-glass in a drop or two of Canada balsam, spreading the grains evenly with a needle, and then putting away to dry. When dry, it is only necessary to add another drop or two of balsam, and to mount on a warm slide in the usual way. By this means the pollen is prevented from running together in the centre of the slide. Pollen makes beautiful opaque mounts. Pollens can be stained readily by any of the aniline dyes, such as methyl blue or green. They must be first soaked in methylated spirit to remove air and colour, then dyed in a strong alcoholic solution of the stain for an hour or two; the stain poured off, rinsed in spirit, this poured away and clove oil added; this again poured away, and mounting in Canada balsam proceeded with as above. Very pretty slides can be made by staining equal quantities of the pollen different colours and mixing them together just before mounting in the Canada balsam. Gentian violet and Vesuvin are bacterial stains, and the former is also used as a general nuclear stain.

A. G., Chorlton-cum-Hardy.—It is not very easy to answer your questions. The amount of mathematics required "to study light" depends upon how far you wish to go in your study, and I should scarcely advise a man to study the subject from its mathematical side who had not a good preliminary grounding in algebra, geometry, and trigonometry, as a basis. Perhaps the best book on algebra for a home student would be Hall and Knight's "Elementary Algebra," and it would be necessary to know practically the whole of this book as well as such an elementary book on Trigonometry as Lock's. In the same way it is not easy to say how much Euclid is necessary. What is really necessary is a sound preliminary mathematical training, and for this the whole of Euclid cannot be considered too much. On the other hand, if you merely wish to understand and follow such simple mathematical expressions as would be found, for instance, in Glazebrook's "Light," I suppose a knowledge of algebraical addition, subtraction, multiplication, and division, and of simple equations, would serve your purpose.

S. P. M., London. I am sorry your questions have remained so long unanswered, but it has been due to the necessity of getting your specimens named, for which I am indebted to the kindness of Mr. E. R. Burdon, the Curator of the Botanical Museum in the University of Cambridge. He says: "The bright reddish-pink cushions on a bit of bark are fructifications of Nectria; the waxy darker coloured pustules on a bit of wood are Dacryomyces; the brown pustules on birch bark are some species of Hypoxylon. All these are fungi. The withered piece of a fruit had two oblong brown bodies, which have got knocked off, but I think they were cocoons or eggs of some insect. The circular patches on the back of a bit of a fern frond are groups ('sori') of sporangia of the fern Aspidium. I am afraid there is no book of a popular nature on the smaller fungi (other than Cooke's). The only way to identify such fungi is to cut sections and see the nature of the fructifications and size and colour of the spores, and then, in most cases, ask an expert."

Communications and Enquiries on M[illegible] addressed to F. S[illegible] [illegible] Cambridge.

The Face of the Sky for April.

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

The Sun.—On the 1st the Sun rises at 5.39 and sets at 6.30; on the 30th he rises at 4.37 and sets at 7.18. The equation of time is negligible on 16th, hence this is a convenient date for the adjustment of sundials.

Sunspots and faculæ are usually conspicuous on the solar disc, whilst recent spectroscopic observations of the limb have shown many prominences.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
April 1 ..	26° 22′ W	6° 28′	169 56′
,, 6 ..	26° 30′ W	6° 9′	103 56
,, 11 ..	26° 27′ W	5 49′	37 57′
,, 16 ..	26° 13′ W	5 25′	331 57′
,, 21 ..	25 50′ W	4° 59′	265 55′
,, 26 ..	25 14′ W	4° 31′	199 51′

The Moon:—

Date.	Phases.	H. M.
April 2 ..	☽ First Quarter	4 2 a m
,, 9 ..	○ Full Moon	6 12 a.m.
,, 15 ..	☾ Last Quarter	8 37 a.m.
,, 23 ..	● New Moon	4 7 p m
,, 10 ..	Perigee	9 24 a m.
,, 25 ..	Apogee	0 54 p m.

Occultations.—The following are the occultations of the brighter stars visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Reappearance. Mean Time	Angle from N. point.	Angle from Vertex.
			p.m.			p.m.		
April 4	π^2 Cancri	5·6	6.37	119°	143	7.52	271°	270°
,, 5	Regulus ..	1·3	5.48	67	102	6.42	327°	356
,, 6	χ Leonis	4·7	7.3	149	181	7.57	253°	277
,, 11	49 Libræ	5·6	10.56	165	197°	11.30	233	261
,, 27	119 Tauri	4·6	8.51	83	42°	9.48	276	238
,, 27	120 Tauri	5·3	9.28	95	56	10.24	263	227
,, 30	ξ Cancri	4·7	11.33	110	70	12.28	274°	236

The Planets.—Mercury (April 1, R.A. $0^h\ 58^m$; Dec. N. 0° 42′. April 30, R.A. $0^h\ 51^m$; Dec. N. 2° 32′) is in inferior conjunction with the Sun on the 5th and hence unobservable at the beginning of the month: towards the end of the month the planet is a morning star in Pisces.

Venus (April 1, R.A. $1^h\ 24^m$; Dec. N. 7° 51′. April 30, R.A. $3^h\ 43^m$: Dec. N. 19° 57′) is an evening star in Aries, setting about an hour after the Sun on the 1st and about two hours after on the 30th. The apparent diameter of the planet is 10″·6, and 0·97 of the disc appears illuminated.

Mars (April 1, R.A. $2^h\ 33^m$; Dec. N. 15° 18′. April 30, R.A. $3^h\ 56^m$; Dec. N. 20° 56′) is an evening star in Taurus, setting about 9.25 p.m. throughout the month. The planet may be observed shortly after sunset looking a little north of west, but he does not appear very bright, as he is at a point in his orbit situated at a great distance from the earth.

Jupiter (April 1, R.A. $4^h\ 7^m$; Dec. N. 20° 22′; April 30, R.A. $4^h\ 32^m$; Dec. N. 21° 26′) is getting more to the west, and is only available for observations for a few hours each evening; about the middle of the month the planet sets about 10.45 p.m.

The equatorial diameter of the planet on the 14th is 34″·6, whilst the polar diameter is 2″·2 smaller.

The following table gives the satellite phenomena observable in this country:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Apr				Apr				Apr			
4	I.	Oc. D.	7 54	12	I.	Sh. I.	7 59	24	III.	Tr. I.	8 22
5	I.	Sh. E.	8 18		I.	Tr. E.	9 17	25	II.	Sh. E.	8 21
6	III.	Oc. D.	9 16	19	I.	Tr. I.	9 4	27	I.	Oc. D.	8 27
7	II.	Tr. I.	9 10	20	I.	Ec. R.	9 26	28	I.	Sh. E.	8 32
9	II.	Ec. R.	7 55	23	II.	Oc. D.	8 57				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (April 1, R.A. $22^h\ 47^m$; Dec. S. 9° 26′. April 30, R.A. $22^h\ 58^m$; Dec. S. 8° 25′) is a morning star in Aquarius, rising about 4 a.m. near the middle of the month.

Uranus (April 15, R.A. $18^h\ 37^m$; Dec. S. 23° 28′) does not rise until after midnight; he is situated low down in Sagittarius.

Neptune (April 15, R.A. $6^h\ 34^m$; Dec. N. 22° 19′) is on the meridian before sunset, but is observable in the west until midnight; near the middle of the month the planet sets about 1 a.m.

Meteor Showers:—

Date.	Radiant. R A	Radiant. Dec.	Name.	Characteristics.
	h. m.			
Apr. 17-May 1	16 0	+47°	τ Herculids	Small; short.
,, 20-21 ..	17 24	+36°	π Herculids	Swift; bl. white.
,, 20-22 ..	18 4	+33°	**Lyrid Shower**	Swift.
,, 30 ..	19 24	+59°	ο Draconids	Rather slow.

Minima of Algol may be observed on the 11th at 11.33 p.m., and on the 14th at 8.22 p.m.

Telescopic Objects:—

Double Stars.—γ Virginis, XII.^{h} 37^m, S. 0° 54′, mags. 3, 3; separation 5″·9. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of a power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.^{h} 36^m, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 40.

ε Boötis, XIV.^{h} 41^m, N. 27° 30′, mags. 3, 6½; separation 2″·6. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue green.

ξ Boötis, XIV.^{h} 47^m, N. 19° 31′, mags. 5, 7; separation, 2″·4. Binary; one component being orange, the other purple.

Clusters.—M 3 (*Canes Venatici*), XIII.^{h} 38^m, N. 28° 48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.

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By ALEXANDER SMITH.

II.

Adapting Telescopes for Photographic Purposes.—Both refracting and reflecting telescopes may be utilised for photographic purposes, but unless the former type of instrument is specially corrected for this kind of work the chemical and visual foci will not be coincident. The difference may be ascertained by making a number of short exposures, and noting the plane at which best definition is obtained. Photographic achromatism is sometimes secured by altering the distances between the crown and flint lenses, and sometimes by using a third lens specially corrected for the purpose. Triple object-glasses suitable for both visual and photographic work are now procurable, but are very expensive. The reflector is, however, the type of instrument which appeals to the ordinary amateur, who is desirous of taking up astronomical photography, as perfect achromatism is secured at a comparatively small cost. To adapt a well-mounted clock-driven instrument of this class for such work, few additional appliances are required. A guiding telescope—either reflector or refractor—will have to be provided, and the aperture should preferably be not less than four or five inches. A plate-holder with suitable carrier will also be required. The latter may be attached to the telescope with a piece of brass tubing of the requisite diameter to slide firmly into the eye-tube. To one of its ends a flange is fitted, by means of which the tube is attached by screws to the carrier, the necessary focussing adjustment being made by the rack of the telescope.

With large reflectors, used solely for photography, a flat is usually dispensed with, and the plate placed inside the main tube at the primary focus of the mirror. The plate thus practically takes the place of the flat, and is supported in a similar fashion by three thin pieces of steel. The plate-carrier is attached to a short length of stout brass tube, inside of which another tube, worked by rack and pinion, slides, and by which the final focussing adjustments are made. The dark-slide is fitted with a shutter, which folds back in the line of focus, where it is held in position by a spring catch. In some cases a flap-shutter is also fitted to the carrier, and is raised or lowered by means of two strings, a small weight attached to either string keeping it in position. In such equipments the mirror has usually a central aperture, through which the brighter objects on the plate can be directly examined with a small telescope, and, in the case of long exposures, it can also be ascertained by the same means whether any displacement of the speculum has taken place.

Enlarging Lenses.—With instruments, such as are generally to be found in the hands of amateurs, the discs of the sun, moon, and planets at the primary focus of the mirror are too small, particularly in the

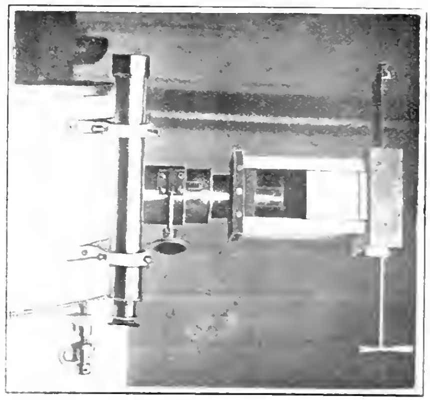


Fig. 3.

case of the planets, to exhibit much in the shape of detail, compared with the results which are obtained visually when an eye-piece is employed. At the same time it is astonishing how much detail can be shown by enlargements from such photographs, if the method afterwards described is adopted. It must, however, be conceded that a negative obtained by enlarging the primary image by a lens in the telescope will exhibit less of "grain" than if the image is directly transferred to a photographic plate and afterwards enlarged to the same dimensions.

Different forms of enlarging lenses may be successfully employed, the most popular probably being the "Barlow" and low-power positive eye-pieces. Very fine results may also be obtained with the negative components of telephoto lenses of the better class, which give a very flat field, and have the additional advantage that only a short extension of camera is required. When it is desired to secure an enlarged photograph of the whole of the solar or lunar disc, the diameter of the lens must, of course, be at least equal to that of the primary image. To bring such lenses into use some form of camera is necessary. This can be attached to the eye-tube of the telescope in the same manner as the carrier previously referred to. Fig. 3, which is self-explanatory, shows the complete arrangement as used by the writer. The enlarging lens is fixed in a sliding tube, and, through the small door with which the camera is fitted, it can be moved nearer to or further from the plate to increase or diminish the amount of magnification, the focussing being accomplished by the rack-work of the telescope. For planetary work a screw similar to that previously described, and which is also shown in the figure, can be brought into use, and several exposures put on the same plate.

Shutters.—It will be found of great convenience for regulating the exposure if some form of shutter is attached to the eye-tube of the telescope. The type adopted should have a fairly large opening, work smoothly, and admit of giving "time" and "instantaneous" exposures. It should be fitted with a short length of brass tube similar to that described for the camera and plate-carrier. It may then be readily placed in position by sliding the tube into the end of the eye-tube which is next the flat, and, consequently, inside the telescope, the release being most conveniently effected by the usual pneumatic ball.

Driving-Clocks.—Many amateurs possess driving-clocks, but only a small proportion of these give sufficiently accurate results to enable their owners to take up photographic work in a systematic fashion. In some cases failure may arise from faulty construction of the mount. The polar axis may be too short to secure the requisite rigidity, or, what is a more common defect, the driving-worm, or pinion, as the case may be, is geared to too small a sector or circle. If a large sector

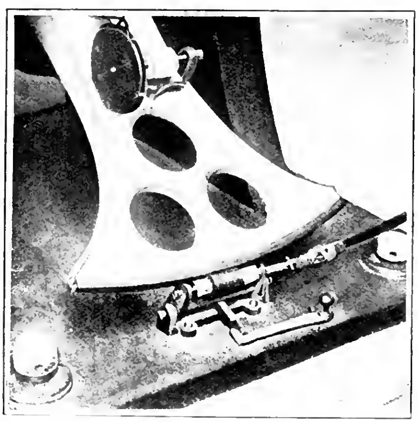


Fig. 4.

be used, very little strain is put upon the driving mechanism, and a greater measure of steadiness is at once secured.

Fig. 4 shows a sector of two feet radius with the driving-worm geared in position. It is very important that both the driving-worm and sector be accurately cut, otherwise slight movements of the image in the field will be apparent, although the motion of the clock may be perfectly regular.

In the matter of clocks, perhaps the most frequent source of trouble arises from the method of control, the ordinary frictional governor being uncertain in

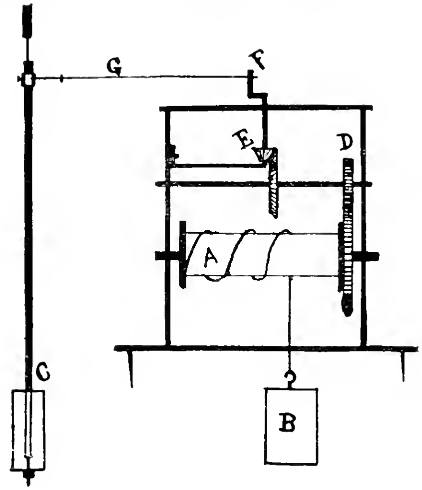


Fig. 5.

action, and, where accurate driving is essential, necessitating the introduction of electrical or other complications. For time-keeping purposes no method of control equals the pendulum for steadiness and reliability, but pendulum clocks in the ordinary form are quite useless for driving astronomical instruments, for the simple reason that they are fitted with escapements, which only admit of motion in the form of short though regular impulses, while for astronomical purposes the motion must be continuous. A clock can, however, be constructed whereby this result is obtained, and the advantages of the pendulum control at the same time secured. When the principle on which its utility depends is once understood the constructional details may be worked out in a variety of ways.

This principle may be made clear by referring to Fig. 5, which is intended to illustrate the action of a train of wheels on a single pendulum. A represents the clock barrel, B the driving weight, and C the pendulum. When the barrel rotates, motion is conveyed through the intervening wheel D to the bevel pinion E, and thence to the vertical spindle F, on the upper end of which there is fitted a short crank, which, in turn, communicates its motion through the connecting-rod G to the pendulum C, and as the latter swings backwards and forwards it regulates the rate of motion of the whole arrangement. A single pendulum will not give so satisfactory results as 3, and this is the minimum number recommended for a clock of the kind.

Fig. 6 is a photograph of a 3-pendulum clock of this description, which the writer found to give excellent results. On the top of the vertical spindle to which the crank is connected a train of small wheels terminating in a "fly" should be fitted, for the purpose of introducing a certain amount of flexibility in the drive between the clock and pendulums, in order that the oscillatory motion of the latter may be started and stopped gradually and without shock, which would not be the case if the pendulums were rigidly joined to the rest of the driving mechanism.

A larger clock controlled by five pendulums, each 3 feet 3 inches long, was subsequently used, and when everything was properly adjusted the motion was so reliable and certain that when engaged in photographic work it was only necessary to examine the image in the guiding telescope at intervals of a few minutes. Notwithstanding extended trials with both types, it is difficult to express a decided opinion whether five pendulums give better results than three. A greater measure of steadiness appears to be secured by adding to their length than by increasing the number. Three must, however, as already pointed out, be regarded as the

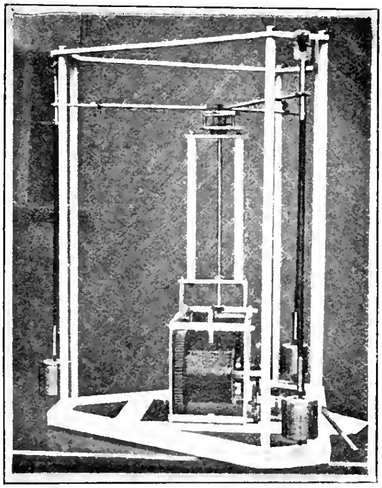


Fig. 6.

minimum, and their length should preferably not be less than three feet.

Having briefly described the various appliances which may be brought into use by those desirous of taking up astronomical photography, a few hints, based on the writer's experience, will now be given regarding methods of working.

Solar Photography.—In selecting plates for photographing the solar image the slowest brand procurable should be adopted; indeed, it may be pointed out as an invariable rule, that, where a sufficiently long exposure can be given with a slow plate, it should always be selected in preference to one of greater rapidity. Rapid plates do not give the same amount of delicate detail, neither do they admit of the same latitude in exposure. It is only in cases where very prolonged exposures are essential that their use becomes a necessity, at least so far as astronomical purposes are concerned. For solar work a good brand of lantern plate will probably be found to give the best all-round results. All plates should be backed with a suitable medium. No hard-and-fast rule can be laid down with regard to the duration of exposure, as this is appreciably affected by the position of the sun at the time the photograph is secured, but as a rough guide it may be stated that on a summer day with the sun placed in a clear sky, and the telescope stopped down to an angular aperture of f/60, an exposure of 1-40th of a second on a lantern plate will be found to be ample. In other words, if a telescope of a focal length of 10 feet is stopped down to an effective aperture of two inches, the exposure required will be about 1-40th of a second. If the primary image is enlarged by a lens, a correspondingly increased exposure must, of course, be given.

Lunar Photography.—In taking photographs of the moon, the beginner will soon discover that, in order to secure the desired amount of detail, the terminator requires a longer exposure than the rest of the illuminated disc, and that by giving exposures of varying duration the apparent age of the moon may be altered by several hours. At least three methods may be brought into use for getting over this difficulty. (1) A strip of cardboard, one end of which is similar in size and shape to the lunar terminator, may be introduced by the hand into the end of the telescope tube, and moved slightly backwards and forwards in front of the shutter for, say, two seconds, and rapidly withdrawn. It is to be understood that during the first part of the exposure the terminator only is to remain uncovered, and, if the shutter is closed after an interval of another second, the terminator will thus get an exposure of three seconds, and the rest of the disc one-third of that amount. (2) The plate may be given an exposure in the telescope suited to the terminator, and afterwards developed. A positive is then taken from the negative by contact, but during the exposure of the plate to the source of illumination a strip of cardboard, similar to that previously referred to, is brought into use, and moved slightly backwards and forwards over the image of the terminator during two-thirds of the total exposure, and then withdrawn. Another negative can be taken from the positive thus obtained either by contact, or, if a camera is used, an enlarged image may be obtained at the same time. (3) The plate may be exposed in the telescope as before, and the resulting negative afterwards reduced in density where necessary by the local application with a soft brush of a reducing solution, such as that known as "Farmer's" (Saturated solution of Ferricyanide of Potassium 1 part, Hyposulphite of Soda solution 1 to 5, 10 parts). If the method first referred to should not give the result aimed at, the defect may be removed by method No. 2 or 3, or all may be partly utilised in the production of a single negative.

If a lens is used in the eye-tube of telescope to enlarge a portion of the primary image, the illumination will be more evenly distributed, and the plate under such circumstances may be treated in the usual way.

Planetary Photography.—Unless a telescope of long focus is available, no very satisfactory photographs of any of the planets can be obtained, and even the best results, which have so far been secured compare unfavourably with the views which a comparatively small instrument presents to the eye of the observer. When dealing with such a small object, it is advisable to use an eye-piece in conjunction with the telescope to enlarge the primary image, and in the case of the brighter planets the aperture should be stopped down to reduce the intensity of the light with the view of being better able to regulate the exposure and development. Care should be exercised that these are not too prolonged, otherwise the small discs will be enlarged by the effect of halation, and all detail effectually obscured.

On the accompanying plate a few examples are given of planetary and lunar photography. With the exception of Fig. 10, where a $10\frac{1}{4}$ inch mirror of 6 feet

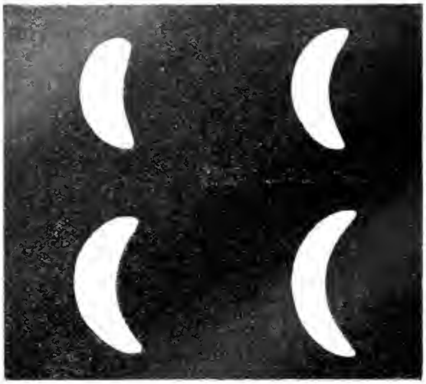


Fig. 7

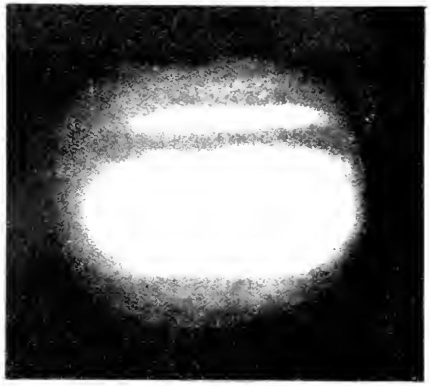


Fig. 8

Fig. 9

Fig. 10

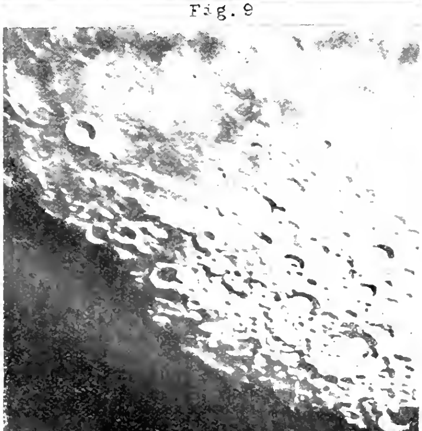


Fig 11

Fig 12

5 inches focus was used, all the photographs were taken with the same telescope, viz., a 12¼-inch reflector having a focal length of 10 feet. This instrument, which was formerly used by the writer, is now in the hands of Mr. Maclachlan, of Largs, who made the original exposures from which Figs. 8, 11, and 12 have been produced. It will be understood that all the original negatives were subsequently enlarged with the camera, and details of the method employed will be given in another paper.

Fig. 7 shows four photographs of the planet Venus, taken January 13, 17, 28, and 30, 1902, at the primary focus of the mirror. A slow plate was used, and the duration of exposure was about half a second. The images were afterwards mounted on a strip of glass and enlarged together.

Fig. 8 is a photograph of the planet Jupiter, the primary image in this instance being directly enlarged in the telescope wth a low-power Ramsden eye-piece. The exposure given was two seconds, and the plate developed with a solution of normal strength.

Fig. 9 was taken at the primary focus of the mirror, the lunar terminator receiving three times the amount of exposure given to the rest of the disc. (See method No. 1 referred to under "Lunar Photography.")

Fig. 10 was taken during the last phase of the lunar eclipse of April 11, 1903. The exposure in this case also was made at the primary focus.

In the production of Figs. 11 and 12 a Ramsden eye-piece was used in the telescope to enlarge a portion of the primary image, the exposure in each instance being 10 seconds. Those who are acquainted with lunar typography will readily recognise the regions depicted on the prints. Fig. 11 shows a portion of the terminator in the vicinity of the craters Bullialdus and Tycho, while Fig. 12 is a photograph of the well-known crater Copernicus and the surrounding region.

(To be continued.)

Simple Rule for Squaring any Number.

RULES for simplifying arithmetical calculations have often been published. The following simple method of squaring any number is somewhat interesting. It ought probably to be taught to beginners in connection with extraction of square root of which it is the converse, and an instructive exercise is afforded by squaring numbers by this method and verifying the correctness of the answer by long multiplication.

Suppose it is required to find the square of 5342·7198, the multiplications being carried to four decimal places; the process stands as follows:—

5342·7198	× 5342·7198	
5000	· 5000	25000000
103	· 3	309
1064	· 4	4256
10682	· 2	21364
10684·7	·7	7479·29
10685·41	·1	106·8541
10685·4	·9	96·1689
10685	·8	8·5483
		28544654·8613

With a little practice, the successive lines of multiplication could be written down mentally without writing down the successive multiplicands and multipliers.

Numbers may be easily *cubed* or raised to any desired power by a kind of reversed Horner's process, very similar in principle to the above, but it is doubtful how far any further extensions of the method are suited for teaching purposes. G. H. B.

Spitzbergen and its Whale Fishery.

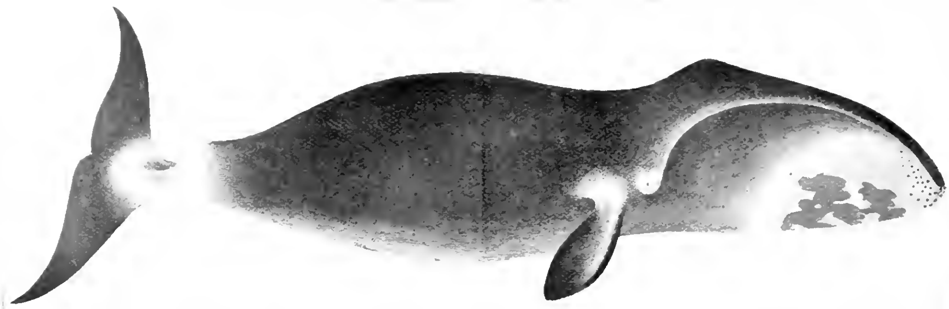
By T. SOUTHWELL, F.Z.S.

IT is only of late years that anything like order has been established in the classification of, or any important advance made in, our knowledge of the distribution and life history of the members of the important family of marine mammals known as the Cetacea, or whales and dolphins, and this especially applies to the whalebone whales of the northern hemisphere. It will hardly be believed that although the great Arctic Right Whale has been known since the year 1610 and many thousands of them killed, so rare is the skeleton of this animal and so difficult for various reasons to obtain, that it is still a desideratum to our National Museum; but owing to the establishment in Northern Europe and America of whaling stations for the pursuit and capture of the giant Fin Whales (Balænopteridæ), rendered possible by the discovery and perfecting of a mode of attacking them by explosive harpoons, the invention of Herr Foyn, a Norwegian whaler, abundant material has been rendered available for their study and accurate description. Still it is very remarkable how slow the general public is to appreciate this advance, and how singularly they fail to distinguish between the various distinctive branches into which the family is divided, even confounding, as will be seen below, those armed with teeth with those furnished with the remarkable appendage known as baleen, or whalebone, the feature on which the main division of the order is based, namely, Mystacoceti, or Whalebone whales, and Odontoceti, or those furnished with teeth.

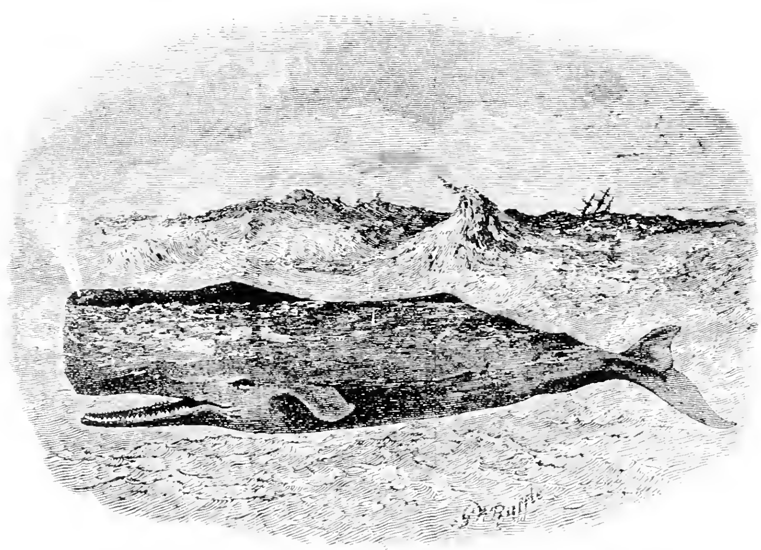
Even in the writings of acknowledged authorities we sometimes meet with strange statements. For instance, in one text book we are informed that a Right Whale may produce several "tons" of whalebone, a most liberal allowance, and at the present price of £2,250 per ton, a very valuable asset; another authority states that the Right Whale, though found in the seas on both sides of Greenland, passing freely from one side to the other, is never seen so far south as Cape Farewell. The first statement is doubtless due to the intervention of one of those evil spirits specially allocated to the office of the printer, who wickedly substituted the word "ton" in the place of hundredweight; the second is probably an oversight, for its author was one of our most accomplished cetologists. That the Right Whale is (or was) found on both sides of Greenland is undoubtedly true, but as it never descends so far south as Cape Farewell it is difficult to understand how it can pass freely from one sea to the other. A charming writer and a leader in the world of science evidently never acquainted himself with the learned researches of Prof. Eschricht, for he adheres to the old belief that the whale formerly hunted by the Basques in the temperate regions of the Atlantic, through persistent persecution has retreated to the ice-fields of the Polar regions, whereas the species inhabiting these two areas are perfectly distinct.

Of late personally-conducted tours have been extended even to the icy regions of Spitzbergen, and, of course, the travellers to this No-man's Land have favoured their less adventurous brethren, by means of the public press, with the results of their peregrinations; and as the tourist is almost invariably furnished with a "Kodak," the illustrations to their articles are, as a rule, excellent, and give a fictitious value to the letterpress which is generally poor stuff enough. Two of these articles dealing with the Shetland Fin Whale fishery, one of which appeared in *Temple Bar* for September, 1905, and the other in the *Illustrated Sporting and Dramatic News* on the 9th of the same month, are all that can be desired, but in a third article, in another illustrated periodical, dealing with a visit to Spitzbergen, the author tells us that "the Sperm Whale, from which the best whalebone is obtained . . . is becoming rare!" It would be difficult, did one try, to embody an equal amount of inaccuracy in so few words.

But a more pretentious article, giving an account of a trip to Spitzbergen and of the whale fishery carried on there by the Norwegian vessels, has recently appeared in an old-established journal, which I have for many years read and admired for its usually short, crisp, and well-informed articles; but in this instance the editor has evidently been caught napping, so far as it relates to whaling, notwithstanding the fact that the editorial chair is usually considered quite other than conducive to somnolence. The author of the paper, after giving a brief history of the discovery of the group of islands and of the flocking thither of the various



The Polar Right Whale (*Balæna mysticetus*).
From an original drawing made from actual measurements by the late Capt. David Gray, of the S.S. "Eclipse," whaler.



The Sperm Whale (*Physeter macrocephalus*).
From Southwell's "Seals and Whales of the British Seas."

nationalities to participate in the capture of what he calls "the 'Right' or *Sperm* Whale," states that "the competing whalers had the good sense not to quarrel on the spot, and a fair division of the spoil (?) was accordingly arranged," a statement than which nothing could be farther from actual facts, as I think the following statistics will show.

Shortly after the discovery of Spitzbergen by the Dutchman, Barentz, in 1596, our countryman, Henry Hudson, followed the same course, and his glowing account of the vast numbers of whales and walrusses there to be found induced the English Muscovy Company, in 1610, to send out vessels for their capture; thereupon, under the impression that the Spitzbergen group formed part of Greenland, the Danish Government at once annexed them, but our James I., not to be behind in securing so productive a territory, lost no time in also asserting a claim to the islands and the adjacent seas, and although the assumption on which the King of Denmark based his pretensions proved not to be tenable, I am not aware that either claim has ever been officially renounced.

In 1612 the Dutch followed us to Spitzbergen, and for the next thirty years a fierce contention raged between the English, Dutch, Danish, and French crews for supremacy with varying success and frequent reprisals, the Dutch and Danes often calling in vessels of war to their assistance, whilst the diplomatists at home fought wordy battles with equal vigour. On the whole, the Dutch, who generally worked fairly harmoniously with the Danes, seem to have had the best of it, and in 1623 they began to erect permanent settlements on the shore for rendering down the blubber, which eventually expanded to a considerable settlement known as Smeerenburg, of the "rise and fall" of which Sir Martin Conway has given such an interesting account in a privately printed pamphlet (undated); they also had depôts in the island of Jan Mayen. For having roughly driven two Biscayan vessels from their fishing grounds, only to subject them to similar treatment from the English, the Frenchmen took a speedy revenge. Staying behind until the Dutch had returned home, they pillaged the Jan Mayen station, loading up with the spoil, which they sold in France, and destroying what they could not remove. After the sack of St. Jean de Luz by the Spaniards in the winter of 1636, when the French whaling fleet was practically destroyed, very little is heard of the Biscayans, and they finally ceased to send out vessels in 1639. In 1642 the much persecuted whales began to abandon the bays where once they had been so plentiful, and the vessels had to follow them into the ice. This led to their adopting the plan of trying out the blubber at sea or carrying it home to extract the oil, thus rendering the shore stations useless, and they were gradually abandoned, till, by 1653, Sir Martin Conway tells us, the once famous summer settlement of Smeerenburg was finally abandoned.

It need hardly be said that the animal which formed the quest of these ancient mariners was the Polar Right Whale, which yields the valuable "whalebone" as well as oil, and that the Sperm Whale, a toothed whale inhabiting the southern seas, was quite unknown to them, or, at most, only occurred as an accidental wanderer in the Arctic seas.

The Right Whale has of late years been practically exterminated in the East Greenland seas, and those now fished for from Shetland, Iceland, and Spitzbergen are various species of "Finners," which occur in considerable numbers and yield a varying quantity of oil according to the species, but far less than the Polar whale; their whalebone is also short and brittle, and of little value. When these whales are killed they rapidly sink, and are difficult to recover; therefore, it has become the practice to pump air into the abdominal cavity to cause them to float, but I never heard of "gas" being injected for that purpose as stated by the magazine writer referred to, and if he is not mistaken it is quite a new departure. Decomposition sets in very rapidly in a dead whale, and the appearance which the author of the paper very excusably mistook for the extrusion of the tongue is a prolapse of the lining membrane of the throat caused by the pressure of the air in the abdominal cavity; this is seen in the case of stranded whales which have been some time dead, and would doubtless be more pronounced after artificial inflation.

The extent to which these Fin Whales have been persecuted since Herr Foyn's invention in the waters of both Europe and America has already greatly reduced their numbers, and it needs no great gift of prophecy to predict their early extermination; they are slow of reproduction, and long in coming to maturity, and the only hope is that when they become too scarce to render their pursuit profitable a remnant may be left to insure the continuance of the race.

I hope it will not be thought that in penning the above remarks I am merely indulging in carping criticism. My object is to call attention to the want of even rudimentary knowledge of these interesting animals on the part of the general public, notwithstanding the many excellent recent works on Natural History to be found in all our free libraries. It might possibly be excused that the uninitiated should fail to distinguish between the Right Whale of the North Atlantic and its relative inhabiting only the Polar Seas; but that the latter should be confounded with the Sperm Whale—so totally different an animal—whose proper home is in the Southern Oceans, is simply incredible.

It is not easy to make the personal acquaintance of these giant animals, but a visit to the whale-room at South Kensington Museum ought to convey much general information, and I can promise those who pursue the study that they will find it a very fascinating one.

Royal Institution.—The following are the Lecture Arrangements at the Royal Institution, after Easter:—Professor G. Baldwin Brown, Two Lectures on Greek Classical Dress in Life and in Art; Professor William Stirling, Three Lectures on Glands and their Products; Dr. P. Chalmers Mitchell, Two Lectures on The Digestive Tract in Birds and Mammals; Rev. J. P. Mahaffy, Two Lectures on (i) The Expansion of Old Greek Literature by Recent Discoveries; (ii) The Influence of Ptolemaic Egypt on Graeco-Roman Civilisation; Professor William J. Sollas, Three Lectures on Man and the Glacial Period; Professor Charles Waldstein, Three Lectures on English Furniture in the Eighteenth Century; Professor Sir James Dewar, Two Lectures on The Old and the New Chemistry; and Professor W. Macneile Dixon, Two Lectures on (i) The Origins of Poetry; (ii) Inspiration in Poetry. The Friday Evening Meetings will be resumed on April 27, when Professor John W. Gregory will deliver a Discourse on Ore Deposits and their Distribution in Depth. Succeeding Discourses will probably be given by The Hon. Charles A. Parsons, Professor J. H. Poynting, Professor Arthur Schuster, Mr. Leonard Hill, Professor H. Moissan, and Professor Sir James Dewar, and other gentlemen.

Irritability.

Reaction of Protoplasm to Stimuli.

By HAROLD A. HAIG, M.B.

PROTOPLASM will react to external stimuli and within limits can adapt itself to stimuli of an unusual and powerful nature. But if these latter be too long sustained a complete or partial cessation of function will result.

Let us take the case of a turgescent root-hair surrounded with a dilute aqueous solution of various salts. Some of these salts will be selected to the exclusion of others, the protoplasm lining the cell-wall, or, rather, the layer known as the ectoplasm, showing what is known as a selective capacity for certain salts. Now this process shows us that the ectoplasm by reason of its reaction to the stimuli of some salts and not those of others acts as a kind of sieve, and keeps up the requisite osmotic equilibrium. A non-living membrane shows no such predilection for some salts over others; in fact, there must exist in our layer of protoplasm the capacity of reacting specifically to some kinds of chemical stimuli over and above others.

Take again the case of naked masses of protoplasm (plasmodia) when subjected to the influence of some irritant: retraction will in some cases occur, in others attraction, and here again we find the same kind of specific irritability. These phenomena are not to be explained on purely physical or chemical lines, but are of a complex nature in which both physical and chemical changes occur. Later on we shall see that rapid changes in metabolism have probably a large share in the production of the various external manifestations such as alterations in shape of the protoplasm, movements, and so on; but some of the intrinsic molecular changes which take place when a stimulus is applied to protoplasm are so hidden that as yet no satisfactory theory has been advanced to explain all the changes which take place between a stimulus and its effects.

In the animal cell we find conditions are somewhat different; in the first place we cannot make any distinction between an outer transparent and an inner granular layer of protoplasm, such as is possible in plant cells, and, moreover, no true cell-wall exists. Under the influence of certain irritants, as, for instance, the mineral acids, we find that living cells from a given part of the body, such as the skin, will, some of them, become completely disorganised, and adjacent cells show signs of increased rapidity of division, a fact pointing to a reparative process, and due to the stimuli transmitted by neighbouring injured cells. Instances of this reparative process occur at times in plants, as in the case of the production of a cushion of callus round the edges of a cut made through the bark of a tree so as to include the cambium and xylem; and in the overgrowth which occurs in certain cases where a parasite attacks a plant.

In those cases where animal cells are exposed to the action of the bacterial toxins, a very complex result often ensues; in some cases, as is well known, the cell will resist the poison, and produce substances known as antitoxins, which tend to arrest or neutralise the action of the bacterial toxin. In other cases toxic bodies are formed outside the bacterial cells from substances either in the animal cell or from the media surrounding them (extracellular toxins), and these, by their irritant action, either kill the cells or stimulate them to form antitoxins.

When a cell becomes incapable of reacting to the irritant, it undergoes a process of degeneration (fatty degeneration), which ends in complete disorganisation and breaking up of the protoplasm into droplets of fatty material. Often certain cells take on a reparative or protective function, and form a layer round colonies of bacteria, enclosing them and finally indirectly affecting their destruction (as in an abscess).

We see, then, that in both the plant and animal cell a definite reaction takes place whenever the cell is exposed to an irritant; in the plant cell there is in most cases either immediate cessation of function, where the irritant is powerful enough, or the occurrence of a physical or chemico-physical process, which tends to remove the protoplasm away from the source of irritation when harmful, and place it in a kind of defensive equilibrium. In the animal cell, on the other hand, the first indication of reaction is one of increased cell-division (where vascular tissues are concerned there is also an emigration of certain cells, leucocytes, which act partly as phagocytes and aim at destroying the irritant), followed in some cases by the formation of a layer of cells, which enclose the irritant and proceed with repair. Now, it may be asked, why should protoplasm react in this manner to stimuli? The retraction of plasmodia away from an irritating substance, and the increased rate of cell-division in the animal cell when stimulated cannot be due to purely physical or chemical causes acting separately. When we say that "irritability" in a plant or animal cell is that property which enables it to react to a stimulus of whatever nature, we merely state the bare fact that by reason of it certain changes occur which somehow alter the previous relations of the protoplasm, but we offer no explanation as to why such changes should occur. As a matter of fact, it is probable that intrinsic changes do take place in the ultimate physical constitution of the protoplasm, whereby a rearrangement of molecules takes place without altering the general chemical constitution. The change, in fact, must be very similar to what takes place when a nerve transmits a stimulus from its peripheral to its central end or *vice versâ*: in this latter process it is known that electrical changes take place, a fact which points to the occurrence of rapidly alternating anabolic and katabolic changes, these manifesting themselves in a current which travels in a certain definite direction.

Recently it has also been shown that any living protoplasm will manifest electrical changes when irritated, pointing to the same anabolic and katabolic changes, and the quiescent protoplasm of seeds which have lain dormant for years will, when an inciting current is passed through them, show what has been called a "blaze-reaction," that is, an electrical response-current, which indicates that the protoplasm is irritable and has reacted. (See Dr. Waller's Experiments with Seeds.)

Experiments such as these have enabled us to gain some little insight into the complex processes involved in the reaction of protoplasm to irritation, but still they do not show us how it is that increased anabolic and katabolic processes are set going subsequent to irritation. That metabolism produces electrical changes is well known, and such changes are, of course, the sequel of any chemical and many physical processes; living protoplasm must be looked upon as being a substance of extremely unstable constitution, such, indeed, that the slightest stimulus will cause an immediate katabolic followed by a rapid anabolic change, both of these being an increase of the usual metabolic changes. This change is capable of being transmitted from cell to cell by means of the protoplasmic connecting strands, and it is thus that we are able even in plants to explain the transmission of stimuli from one part to another of the same organism.

The anabolic change is to be looked upon as a process tending towards repair, but the protoplasm remains in the same unstable equilibrium as before.

Protoplasm that has been killed has passed into a state of stable chemical and physical constitution, and has undergone a complete change with regard to the arrangement of its individual molecules; in fact, it is the very instability of living protoplasm that endows it with its peculiar property of responding at once to stimuli. Protoplasm once dead is open to the ordinary processes of chemical decomposition, but on account of the stable arrangement of its molecules is no longer capable of responding to external stimuli. One of the most important conditions for the retention of irritability is the presence of oxygen, whereby metabolic changes can proceed; and the presence of water both in combination with the protoplasm and otherwise is essential, all living protoplasm having some "water of constitution" which is present in the protoplasm of the driest seeds. Naturally, in living protoplasm, anabolic and katabolic changes are always proceeding to a certain extent, and when above we mentioned the rapid succession of these processes as being one of the essential concomitants in the reaction of protoplasm to stimuli, it was meant that these processes occur then with greater intensity and in regular alternation. A "Current of Rest" is always present in living protoplasm, but when a stimulus is given to it, anabolism and katabolism proceed with a fixed period of alternation, and with greater intensity than before, giving rise to an increased current or "current of action"—very similar to what happens when a muscle passes from a state of rest into one of contraction.

In fact, a close analogy might be drawn between a muscle and a cell; a muscle responds to a stimulus by contracting, and during this contraction certain electrical changes take place, metabolism is increased, and heat is produced; the protoplasm of a cell responds to stimuli by, perhaps, some alteration in shape, or in some cases by more rapid movement round a cell cavity, and during this metabolism is increased and electrical changes take place. But in both cases it is probably the more rapid succession of the metabolic changes, consequent on the stimulus, that is the cause of the outward manifestation; as to the alteration in the physical arrangement of the molecules, this is as yet undetermined, but, with the increase in scientific knowledge, will no doubt be explained at a later date.

Rare Elements.—A revised table has been compiled by Mr. E. L. N. Armbrecht, and is published by Messrs. Armbrecht, Nelson & Co., of the Rare Elements. The table, which is of considerable interest as well as of great utility, gives the symbol, specific gravity, atom's weight, principal source, and chief properties of each of some seventy of the rare elements. The name of the discoverer and in some cases the name of the chemist who first isolated the metal or element is also added, and, by no means least in importance or interest, the market price of the element is furnished. From this it appears that, subject to the natural fluctuations, Yttrium, Vanadium, Thorium, Tantalum, Ruthenium, Rubidium, Rhodium, Niobium, Lanthanum, Iridium, Indium, Erbium, Beryllium and Barium are the chief of the rare elements which are worth upwards of a shilling a gram.

The Chemistry of Proteids.

By Ida Smedley, D.Sc.

Of the three great classes of substances which form the chief products of animal metabolism—fats, carbohydrates and proteids—the last-named have for long withstood all efforts to determine the nature of their constitution. Although this problem has occupied the attention of more workers than almost any other group of substances, it is only within the last five years, chiefly owing to the brilliant work of Emil Fischer and his pupils, that we are in a position to form some definite conception of the nature of their atomic structure. The steps made in this direction have so far only led us to the synthesis of peptides, substances of much smaller molecular size than the native proteids, bearing, however, considerable resemblance to them, and occurring among their cleavage products. Such syntheses may probably be regarded as analogous to those of the simple hexose sugars, the structure of starch and of the more complex carbohydrate molecules remaining unsolved.

The earlier investigators were very largely concerned with the isolation and classification of individual proteids; the latter based mainly on differences in two physical properties, temperature of coagulation and solubility in the presence of inorganic salts. Unfortunately in dealing with these colloidal substances, the identification of chemical individuals presents great difficulties, the properties relied on in classification being those which would be readily affected by the presence of impurities. It has recently been shown that members of two of the most sharply differentiated of these classes, the albumins and globulins, under certain conditions suffer mutual conversion. A more satisfactory scheme of classification will probably be based on differences in their chemical structure, but for this, a knowledge of their decomposition products and the proportions in which they are present, more complete than we at present possess, will be necessary.

The colour reactions given by the proteids when treated with various reagents were also investigated, and some attempt made to allocate the groups in the molecule characteristic of special reactions; in this field our knowledge, though recently considerably extended, is still far from complete.

A study of the gradual decomposition of proteids by hydrolysing agents, both acids and enzymes, resulted in the separation and classification of the non-crystalline derivatives of digestion, albumoses, and peptones, and also in the isolation of a number of crystalline amino-acids, the best characterised being leucin and tyrosin. In the recent extension of our knowledge of these simpler decomposition products, the work of Kossel and of Emil Fischer stands pre-eminent; the former isolated his so-called "hexone bases" arginine, lysine, and histidine, the constitution of all of which has now been definitely established. To Emil Fischer we are indebted both for the isolation of new compounds and for definitely establishing the constitution of products which former investigators had only succeeded in separating. The problem of the structure of proteids may be attacked both by analytical and synthetical methods, the latter being dependent on the former, since the simple decomposition products isolated will afford a clue as to the materials to be employed in synthesis. Now, although the number of these ultimate products identified has been recently much increased, the substances isolated all belong to the class of amino-acids; that is, they contain the characteristic acid carboxyl group "COOH" and the amino group "NH_2," or a derivative of this. It has, however, been shown that in addition to the mono- and di-amino acids, examples of which were already known, a new class of amino-acids in which the nitrogen is bound up in a ring, is present; as instances of these cyclic nitrogen-containing acids and pyrrolidine carboxylic acid, isolated by Fischer and represented by the formula

```
CH2—CH2
 |    |
CH2  CH. COOH
  \  /
   NH
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may be cited, and histidine and tryptophane are other members of this class.

The presence of oxy-amino acids among these cleavage products is of interest since these may form a link between carbohydrate and proteid in the animal organism.

In all, the identity of about twenty of these products is now established, but the number of these obtained from any one proteid varies considerably; from the decomposition of casein, the chief proteid present in milk, as many as sixteen of these acids have been isolated, whilst the comparatively simple protamines obtained by Kossel from the sperm of fishes give only three or four of them.

These amino-acids form, therefore, the starting point of all attempts at synthesis. In order that the synthesis may be successful, two conditions are requisite; in the first place, the synthetic substance must possess the properties characteristic of the proteids; it should give certain colour-reactions, notably a pink or violet colour, when solutions of copper sulphate and caustic soda are added and known as the "biuret" test; it should be similar in physical properties, and it should be broken down both by mineral acids and by the proteolytic enzymes giving simple amino-acids. The second condition is that the method of synthesis should lead to a product the constitution of which may be easily elucidated. Neither of these requirements was fulfilled by the earlier attempts at synthesis; it is true that Curtius as early as 1882 isolated his "biuret base" as the result of the spontaneous decomposition of ethyl glycine, but its constitution was only determined two years ago by its discoverer after it had been shown by Schwarzschild to be decomposable by the pancreatic enzyme, trypsin. The only systematic attempts at synthesis are those of Emil Fischer, who has succeeded in finding a general method by which long chains of amino-acids may be built up into complicated molecules of undoubted chemical individuality and of determinate structure. The method appears capable of wide application, and consists essentially in treating the chloride of a halogen-substituted amino-acid with an amino-acid ester. The resulting ester is saponified, and the halogen atom subsequently removed by treatment with strong aqueous ammonia.

This is represented by the following equations :—

$$CH_2\,Cl.\,COCl + NH_2.\,CH_2\,CONH.\,CH_2\,COO\,Et$$
$$\longrightarrow CH_2\,ClCONH.\,CH_2.\,CONH.\,CH_2\,COO\,Et$$
$$\longrightarrow CH_2\,ClCONH.\,CH_2\,CO.\,NHCH_2\,COOH$$
$$\longrightarrow CH_2\,NH_2.\,CONH.\,CH_2\,CONH\,CH_2\,COOH$$

These condensed amino-acids are termed by their discoverer "peptides," the number of amino-acids coupled up being signified by the prefix di, tri, tetra, &c. Many of the decomposition products of native proteids have been used as the building-stones in this method; glycocoll, alanin, leucin, tyrosin, and several others have been made to react with the chlorides of halogen derivatives of different fatty acids, and a great variety of products have thus been obtained, as many as five acids having been built up into one large molecule. The properties of these polypeptides vary with the radicals employed; they show less disposition to crystallise as the number of residues built up increases; they are soluble in water, those produced from optically active acids being most soluble; they are precipitated by the re-agents used to precipitate proteids, many give the biuret reaction, and if tyrosin be one of the acids used in their synthesis Millon's reaction is also given. In addition, those built up from tyrosin and leucin are acted upon by trypsin, these acids being split off as in the action of enzymes on proteids. The peptides show, therefore, properties closely analogous to those of the proteids, and the manner in which they are built up furnishes us with valuable evidence as to the probable atomic structure of the proteids themselves.

Substances similar to these synthetic polypeptides have now been isolated by Fischer from the products of hydrolytic decomposition of proteids, and this furnishes strong evidence that the method of combination in these compounds is closely allied to that in the proteids themselves. The hydrolysis by enzymes or acids consists essentially in the addition of the elements of water and in the subsequent splitting up of the proteid molecule. This decomposition is gradual, and takes place in successive stages, smaller and smaller molecules being split off. Various investigators have brought forward different schemes by which this action may be represented; most of these are open to dispute, for much remains to be known as to the exact relationships obtaining between these products. The proteid goes into solution in the presence of alkali or acid in the form of alkali or acid-albumen; this is followed by the appearance of albumoses, and at a later stage peptones are detected, all which substances give the biuret test. Much discussion has raged round the number and nature of the albumoses and peptones formed. By some investigators they are classified into two groups, one of which is completely resistant to the further action of enzymes, and remains, therefore, as an end product of enzyme digestion; the second group, on the other hand, is readily attacked by these agents. It has for long been known that proteids are much more readily and completely broken down by the action of acids than they are by the action of enzymes. It has now been shown that although the action of the latter is very much slower, it may be nearly as complete as that of acids. Fischer and Abderhalden carried out a series of experiments in which proteids were digested with pancreatic ferment for as long as seven months; at the end of this period hardly any trace of the biuret reaction was observable in the solution. Since the biuret test is characteristic of both albumoses and peptones, it follows that both these substances had disappeared, and can no longer be regarded as end-products of the action of enzymes, their power of resistance being only one of degree. The solution thus obtained by prolonged pancreatic digestion contained not only the acids already identified, but, in addition, a complicated polypeptide, giving a barely perceptible biuret reaction, and decomposed by further hydrolysis with acids into six already isolated amino-acids.

Other observers, notably, Zunz and Pfaundler, had already pointed out that if one endeavours to trace quantitatively the course of proteid decomposition by estimating the amount of nitrogen in the various products separated at the different stages, there is from the very earliest period a considerable discrepancy when this is compared with the amount of nitrogen in the original proteid.

This must mean that substances are formed which are not detected and isolated by the methods made use of for this purpose, and that a large proportion of soluble nitrogenous products, not giving the biuret reaction, are formed. Pfaundler succeeded in showing that these products, if submitted to the action of acid, gave rise to amino-acids, which could then be detected in the solution. These products are, then, similar to the polypeptide now isolated.

Another point that has been clearly established is that these amino-acids vary greatly in the ease with which they are split off. Leucin and tyrosin are the two first amino-acids to appear and separate at a comparatively early stage of digestion. It is true that these acids are more easily detected than many of the others, but careful search has failed to detect the presence of other acids at an equally early stage, and in this connection it is interesting to note that the synthetic peptides built up from these acids are the ones which were found to be attacked by enzymes.

These soluble polypeptides possibly form a kind of resistant nucleus in the proteid molecule. The view that a resistant nucleus remains after various simpler groups have been split off has long been held; its nature has been much debated, and is still unsettled, though the theory that it is a polypeptide-like body finds considerable support.

We may regard the proteid molecule as built up, therefore, of a large number of amino-acids, the structure of which suffers very little change in this incorporation, so that these acids are again readily split off. The nature of this linking is probably that indicated by Emil Fischer and described above. Certain of these groups appear to offer a more vulnerable point of attack on which the hydrolysing agent seizes to begin the demolition of the molecule. This demolition only can proceed gradually, resistance being offered at every stage.

The great problem of the method of absorption of proteids from the alimentary canal, of which so little is known and which is yet of such vital importance, is intimately bound up with the question of proteid chemistry. We can trace the digestion of the proteid in the alimentary canal and detect there albumose and peptone, but in the blood vessel which carries away the products of digestion neither albumose nor peptone can with certainty be detected, and we can detect no increase in its proteids as the blood leaves the alimentary canal after a meal. The detection of small quantities of albumose and peptone in the blood would not be easy, and a slight increase of proteid might readily escape observation, for the estimation in such a dilute solution does not permit of extreme accuracy. On the other hand since the breaking down of the proteid is more complete than was at one time supposed, the nitrogenous matter may be absorbed in the form of some of these simpler soluble substances, which have for so long remained undetected; indeed, it is found that peptides and amino-acids administered as food, lead to an increased excretion of urea.

Certain feeding experiments have been carried out with the object of throwing light on this most difficult and most fundamental of problems. Lowi showed that nitrogenous equilibrium may be maintained in dogs fed with the crystalline cleavage products resulting from the pancreatic digestion of proteids, which no longer give the biuret reaction. The experiments of Abderhalden do not fully support this; he found that casein and the products of pancreatic proteolysis of casein were equally efficacious as foods; this solution, however, still gave a biuret reaction, and if the digestion were carried further by treating the proteid with acid, death resulted if the feeding was continued for long with such a solution. Further development of such work is desirable, for it would be of the very greatest importance if it could be established that the complicated proteid is not an essential food for the maintenance of animal life.

Now that the synthesis of the simpler carbohydrates is an accomplished fact and that of the simpler proteids has been brought within the region of probability, the old distinction at one time drawn between plant and animal foods loses much of its force. Plants we know can from the simplest materials, carbonic acid and water, manufacture carbohydrate, whilst their nitrogenous food may be supplied to them in the simple form of nitrate or ammonium salt. Animals, on the other hand, require carbohydrate and proteid to be supplied ready-made, some living organism having already accomplished the work of elaboration. It is not so very long since these substances seemed almost removed from the possibility of synthesis; it was as if they were divided off by barriers, akin to those that were supposed to separate organic and inorganic substances before the first organic compound had been synthesised in Wohler's laboratory. If now it can be shown that it is merely a question of the form in which the simple food is supplied, and that an assortment of these comparatively simple amino-acids will serve as nitrogenous food, the difference between the complexity of plant and animal food becomes of a much lower degree, and the idea of a synthetic laboratory food no longer is to be regarded as an impossibility.

The Work of Radium.

What is the work that is being done by radium as it continues—for 30,000 years or more—to shoot out atoms and electrons? Some attempt to give a concrete illustration of its accomplishment has been made by M. Holzmuller, in continuation of the calculations made by Dr. Wien. A milligramme of radium shoots out some 20,000,000 negative electrons every second with a speed approximately five-sixths that of light. These are the β rays. It is also sending out α rays which are particles much more massive, but the speed of which is only one-eighteenth that of light. The amount of work which is thus being done can, of course, only be expressed in "ergs." M. Holzmuller's calculations take as their starting point that a milligramme of radium bromide is doing work equal to 72·2 ergs a second. But the pure radium in radium bromide is only three-fifths of the whole substance, so that the radium is actually doing more work than this; and to cut these calculations down to their smallest possible proportions we arrive ultimately at the estimate that a milligramme of radium before it has exhausted all the energy occluded in its atoms will have done some ten billion ergs of work. In other words, it will have done work equal to 100,000 kilogrammètres; and, to make the final mathematical reduction, a gramme of radium, which is a very small crumb of material, exhausts in the course of its life an energy equal to work at the rate of one horse-power for 15 days.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Developable Image.—During the last few months there has been a good deal published about the developable image. The speculations as to the character of the change wrought in the silver salt when it is converted from the non-developable to the developable modification may, as always before, be divided into two classes, namely : (1) those in which decomposition of the silver salt is assumed, and (2) those in which it is taken for granted that the salt is not decomposed. Some of the more recent ideas can claim no other novelty than that they are expressed in more modern terms, for with so simple a substance as silver bromide there is not very much scope for ingenuity in devising suggestions as to its possible changes. When a chemical change, that is, decomposition, is assumed, it is considered that there may be formed a solid solution of a silver bromide that contains less bromine than AgBr, or, perhaps, of metallic silver, in the unchanged bromide. Assuming that there is no decomposition of the molecule, it is suggested that the change may be due to the loss of an electron.

The one certainty that underlies all these speculations is that there is a change. I think that we may go a step further and state that the change is of a physical kind, because I believe that it is impossible to conceive of a change that is not physical. But as to whether the change goes a stage further and actual decomposition results, or if the change is physical only, the nature of it, are problems that appear to be but little affected by recent publications. It is easy to say that certain theories are in accord with certain experimental results, but the difficulty is to find a theory that will fit all the facts. A catalogue of the known properties of developable silver bromide would be of much more use than a great many of the suggestions as to its constitution, and the list would certainly show that several of these suggestions cannot be true. If such a catalogue were made, some idea of the character of the evidence upon which each of the supposed properties rests should be given, for some investigators have a most unfortunate way of mixing up their theoretical ideas with their experimental results.

Precision in Photography.—I suppose that there is no other art that is practised in so happy-go-lucky a way as photography, even when taken up by those who have been trained in accurate manipulation. The precision wanted is not in compounding developers to within a unit or two per cent., nor in timing development to a second, this would be foolishness and not exactness, but it is surprising, for example, how rare is the ability to focus critically. In the majority of cases it is not due to defective vision, but merely to a careless want of appreciation of what critical focussing is. Perhaps the inherent inexactness of work done by holding a camera in the hand has something to do with it, but the chief reason appears to be that the attitude of even scientific persons towards photography is often strictly comparable to that of the very ignorant with regard to microscopy, whose notion is that anyone can look at an object through a microscope and see an enlarged representation of it. We have improved a little in this during the last few years, but not very much. The successful practice of any art requires a sympathetic appreciation of its possibilities, and a clear understanding of the requirements of each particular application of it.

Uranium Toned Prints.—Uranium toned bromide prints are notoriously so unstable that those who desire the warm colour they show would do well to try toning with copper ferricyanide instead. It is curious that a uranium intensified negative has the reputation of stability, and appears to deserve it, though there is no sufficient reason to doubt that the change is the same in both cases. M. L. Lemaire states that he has traced the liability to change in prints, to the presence of silver ferrocyanide, and says that if this is removed they become stable. He proposes to remove it with potassium thiocyanate, or by treating the prints with a weak alkali followed by dilute nitric acid. This last method must present difficulties, as alkaline solutions will remove the uranium compound. Although the fact is undisputed that uranium toned prints are very liable to fade, the reason is still not clear. Indeed, the exact change that takes place during toning and the composition of the resulting image do not appear to have been determined.

Received.—Messrs. Ross, Ltd., send their catalogue for 1906, which includes their well-known lenses, several between-lens shutters, including a new one, the "Koilos," and cameras, &c.

Mr. Butler, of 20, Crosby Road, Birkdale, Southport, sends a new illustrated pamphlet of his patent "swincam" camera stand.

"What can be done with a Goerz lens?" is an excellently illustrated pamphlet, from C. P. Goerz, 1, Holborn Circus, that describes the various uses and capabilities of the several kinds of photographic objectives made by this firm.

A copy of either of the above will be sent on application to the firm concerned.

Correspondence.—H. E. McColl.—The process of chlorinating the developed but unfixed plate, dissolving out the silver chloride with ammonia and then reducing the silver bromide, does give a fogged image for the very reason you suggest. Probably the seeming discrepancy between the amount of bromide left in the high lights and the fogging is apparent only, it is difficult to judge by the mere appearance. You might try the effect of omitting the ammonia and communicate the result if of interest. It is not possible to say anything about your second experiment as the composition of the film you started with is not known except to the makers. The conversion of P.O.P. into a development paper is not new.

Papers Read.

At the meeting of the Zoological Society held on March 6, Mr. R. Shelford read a note on flying snakes alluded to elsewhere; the other communications at the same meeting consisted of reports on the organisms obtained from Lake Tanganyika and other Central African lakes during a recent expedition. Of these, Mr. Boulenger took charge of the fishes, Dr. Calman reported on the crustaceans, Mr. Edgar Smith discussed the mollusks, and Mr. Kirkpatrick described and recorded the sponges. At the meeting of the same Society held on March 20, Mr. Thomas described a new form of brown bear from the Shan States of Upper Burma, which is of special interest from the fact that bears of this group have hitherto been quite unknown from this district. Mr. G. A. K. Marshall, on the same occasion described no less than 22 species of beetles belonging to the genus *Sciobius*; while Dr. Gadow discussed the evolution of the colour-pattern and the arrangement of the scales in the Mexican lizards of the genus *Cnemidophorus*. At the meeting of the Geological Society on March 29, Mr. S. S. Buckman discussed "homœmorphy" in brachiopods.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Temperature of the Sun.

M. Moissan has recently published another section of the results of his investigations on the distillation of various substances in the electric furnace, and that in relation to titanium is specially important for solar physics by reason of the widespread occurrence of that element in the solar spectrum, occurring as it does in both chromosphere and sun spots. Unlike boron and carbon, which appear to distil directly into vapour from the solid state, titanium was found to assume the liquid intermediate state, and by careful measurements with specially constructed thermometers it is possible to gain an approximate estimate of the temperature of volatilization. Using a current of 1000 ampères at 55 volts, he found that, starting with 300 grammes of material, after seven minutes about 110 grammes had been distilled. Various measures of the arc temperature have been made, the best of which is probably that of Violle, who estimates the maximum temperature to be about 3500° C. In transferring this to estimates of the solar temperature, however, the fact must be remembered that the pressure at the sun's surface may be vastly different to our terrestrial atmospheric pressure, and thus the temperature at which a certain metal can exist as vapour may also be greatly modified.

Terrestrial Shadow Bands.

An interesting account of the observation of terrestrial shadow bands is communicated to the Bulletin of the French Astronomical Society by M. A. Chevremont, who was particularly struck with their similiarity to the moving shadows seen just before and after the total phase of solar eclipses.

The observations were made in Quiberon Bay, during the stay of the North Squadron. During the night exercises the powerful searchlights from the warships repeatedly rested on the white vertical walls of the buildings on shore. The dark bands, very clear, with an undulating motion, were from 10-15 cm. wide, and had a motion of 4-5 metres per second. The wall forming the screen was oriented to the East, and was placed perpendicularly to the rays from the projectors, of which the distance was about 3½ kilometres. Under those conditions the bands were displaced from the North to the South. They were best seen at about 10 metres distance. Similar fringes were seen on another wall oriented North-east to South-west, thus being very oblique to the line of rays, and in this case, as before, the shadows moved from right to left.

Relation of Solar Prominences to Magnetic Storms.

Very definite coincidences were observed on several occasions during 1905 between the outburst of special prominences and movements of the magnetic needle.

On January 29, 1905, a very remarkable eruption was observed which appeared to proceed from the centre of the great spot group, then near the east limb, but it was very notable that no metallic reversals were visible. In the same spot region, however, strongly metallic eruptions were detected by Professor A. Fowler on February 2, 1905. Later in the year, on November 10, 1905, Mr. J. Evershed observed another metallic eruption at 9^h 15^m to 9^h 35^m a.m., during which the sodium, magnesium, and enhanced iron lines were brilliantly reversed for some time. It is very important to note that the magnetograph records at both Greenwich and Stonyhurst Observatories show very minute disturbances on February 2 and November 10, exactly at the times of active phase of these two metallic eruptions.

New Catalogue of Bright Stars.

A most useful catalogue of the brighter stars has recently been published by M. J. Bossert, one of the astronomers at the Paris Observatory. The best positions have been adopted for stars in both hemispheres, and brought up to the epoch 1900. The list contains the co-ordinates of 3800 stars, giving the right ascension and north polar distance; the limit of magnitude is 7·0. A rather peculiar but useful arrangement is that the stars are grouped in zones of 1° of polar distance, and then ranged in each group by their right ascensions, instead of the more common one of order of right ascension throughout. A very complete introduction gives all the necessary details and formulæ for computing the star places at other epochs.

BOTANICAL.

By G. Massee.

Desert Vegetation.

It has long been known that the plants of desert regions possess marked peculiarities, both morphological and physiological, which enables them to retain a foothold under such exceptional surroundings. With the object of investigating these matters under the most favourable conditions the Americans have established a Desert Botanical Laboratory at Tucson, Arizona.

The water relations of the plants of arid regions are so very delicately adjusted that a very slight variation in the available supply, or in the relative humidity of the air, produces a very quick and notable effect. A shrub called Ocotillo (*Fouquieria splendens*) responds quickly to an increase in the water supply. Owing to a long period of drought, a specimen of this plant had, up to June 29, been for several weeks without leaves. On June 29 three gallons of water were poured slowly on the ground at the base of the plant; on July 1 leaf-buds were observed, which at 2 p.m. on the following day had become 1 cm. long, and four days afterwards the leaves were full grown. Other plants of Ocotillo showed the same response to an increase in the water supply.

Palo verde is so called because not only are the leaves green as in other trees, but mainly on account of the green colour of its twigs, branches and stem, all of which are probably capable of giving off water vapour from their surface, and also capable of assimilating carbon dioxide. Palo verde has a low rate of transpiration, and the possible range of transpiration is also small as compared with other desert forms; that is, the maximum rate in summer, when the leaves are on, is not much greater than the minimum, when the leaves have fallen, as is the case with other desert plants that have been studied. In cases of extreme drought the leaves are shed, consequently the area of transpiration is reduced and the necessary adjustment of the rate of transpiration is accomplished.

The period of activity of plants depends on the period during which they retain their leaves. In the case of desert plants growing under adverse conditions, in addition to the large amount of moisture present in the air—which retards transpiration and thus assists the plant in reserving to some extent the amount of water at its disposal—it is considered probable that the leaves absorb atmospheric moisture in sufficient quantity to be of biological importance.

It has been proved that stems of Ocotillo absorb both water and atmospheric moisture; it has also been shown that a branch of Ocotillo without leaves can absorb a sufficient amount of water to induce the formation of leaves.

Plant Life in Spitzbergen.

Dr. Wulff, who accompanied a Scientific Mission to Spitzbergen, paid special attention to the ecological condition of the flora. Transpiration was found to be very feeble and without marked diurnal periodicity. This imperfect transpiration is considered as one of the causes of the feeble growth of Arctic vegetation. Anthocyanin is present in about half the number of the higher plants. It is always absent from plants growing on soil mixed with the dung of wild birds, whereas it is present in the same kind of plants when growing in impoverished soil.

Anthocyanin is considered as an absorber of energy, and without it no plant can become dominant in Arctic regions.

Fossil Conifers.

Some interesting discoveries of fossil plants from the Portland beds of Boulogne have been described by Flicke and Zeiller. One is a cone of *Sequoia* of the *S. gigantea* type, which is named *S. portlandica*. Previous to this discovery the oldest known cone was *S. lusitanica*, from the Wealden beds of Portugal, which belongs to the living *S. sempervirens* type. We have now evidence of the existence of the two living types of *Sequoia* as remote as the Jurassic period, hence the origin of this genus must be very remote.

Pine cones were also found representing the two leading groups, *Strobus* and *Pinaster*, living at the present day. One cone, named *Pinus sauvagei*, is said to closely resemble small cones of the living *P. laricio*. This discovery in like manner indicates the great antiquity of the genus *Pinus*.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Lead Poisoning Through Electrolysis.

A FRESHLY-CUT piece of lead remains untarnished when kept in a closed flask of pure water from which all air has been removed by boiling, but exposed to the simultaneous action of air and water is rapidly corroded, a considerable amount of the metal being dissolved. This action is almost entirely prevented by the presence of the small quantities of salts, notably the carbonates and sulphates commonly present in drinking water, and hence there is usually little risk of lead being dissolved to any dangerous extent by such water. The presence of carbonic acid in the water has a similar protective effect, a thin film of insoluble lead carbonate being formed upon the surface of the metal and protecting it from further action. In the case of soft lake waters the small proportion of vegetable matter generally present plays the same part, forming a compound with part of the lead oxide first produced, which acts like a natural varnish to check the solvent effect of the water. For these reasons lead pipes can be used for conveying the water for household supply, and have usually been regarded as free from danger; but a remarkable case recently recorded by Mr. B. Latham points to a hitherto unexpected possibility of poisoning resulting from the use of lead pipes. The inhabitants of a cottage to which the water was supplied by the South Hants Water-Works were found to be suffering from lead poisoning, and an examination of the supply-pipe showed that corrosion of the metal had taken place. The cause of this was finally traced to a leakage from an electric lighting main close by, and a current with a voltage of 1.8 was detected between the earth return and the lead water pipe. This had caused electrolysis of the metal, which had been brought into solution in sufficient quantity to render the water poisonous. The correctness of this conclusion was established by experiments on a small scale in the laboratory.

Industrial Use of Carbon Tetrachloride.

During the last six months, the use of carbon tetrachloride as a solvent for fats, has become very general in Germany, and it will probably, ere long completely supersede the dangerous carbon bisulphide or petroleum spirit. Carbon tetrachloride is a colourless, mobile liquid, closely resembling chloroform in its general characteristics, though it has no anæsthetic power. It boils at a low temperature, is readily evaporated and condensed, and has the great advantage of being non-inflammable, so that when used for the extraction of fat from bones or other material, the risk of fire is reduced to a minimum. Factories can thus be placed near other buildings, which was out of the question with the highly inflammable solvents hitherto employed, and the fire insurance companies will accept very much smaller premiums. Carbon tetrachloride has a faint characteristic odour. Its vapours are stated to have no injurious effect upon the health of the work-people, and although this point has not yet been definitely determined, they must certainly be much less hurtful than the vapours of carbon bisulphide, which are very poisonous. Special apparatus is required for extracting fat with the new solvent, and this has already been put up in a large number of factories.

The Bacterial Origin of Vegetable Gums.

Three species of bacteria, discovered by Mr. R. Greig-Smith, in the gum and bark of *Acacia binervata*, *A. penninervis*, and *Sterculia diversifolia*, respectively, produce gum when grown on suitable culture media, such as a solution of fruit sugar (lævulose) with glycerine, and traces of asparagine, tannin, and other substances. Strangely enough, glucose and cane sugar interfere with the production of gum by these bacteria, but on the other hand a new gum-producing bacterium was isolated from the sugar cane, in addition to *B. vascularum*, the cause of the so-called "Gum-disease." Experiments were made in inoculating plants belonging to the *rosaceæ*, with acacia bacteria, and gum was subsequently found to have been produced within the cellular tissue. It is not improbable that this discovery may have a commercial value. In Mr. Smith's opinion, all gums that exude from trees are probably of bacterial origin.

Gioddu: A Fermented Milk.

The inhabitants of the mountainous districts of Sardinia eat large quantities of a fermented milk, resembling koumis or kephir. It is prepared by allowing the milk of the cow, sheep or goat to ferment at a moderately high temperature, either spontaneously or after the addition of baker's yeast, until it thickens into a more or less consistent homogeneous mass, at which stage the fermentation is stopped by plunging the vessel into cold water. The product, which has a sharp acid flavour, is eaten either by itself or is spread as a butter upon bread.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Glacial Drift at Moën and Rügen.

THE Rev. Edwin Hill, F.G.S., has laid before the Geological Society the results of his observations on the strange intercalations of drift, which occur in the chalk at the island of Moën. At first sight the drift appears to be interstratified with the chalk, but accepting the theory that the drift was deposited in dislocations in the chalk, it has also generally been assumed that the dislocations were either simultaneous with, or subsequent to, the deposition of the drift. Mr. Hill has, however, examined certain cavities in these dislocations which had been water-worn, and therefore must have been produced before the advent of the drift. It is contended, therefore, that the chalk had been disturbed in pre-glacial times, and the assumption is that there were pre-glacial hills and cliffs similar to the present, with similar clefts and furrows in the cliffs, which were covered in glacial times with a mantle of drift, which is now in course of removal by denudation. This, indeed, seems to be the most natural assumption. Some geologists have endeavoured to show that the intercalations of drift in the chalk both at Moën and Rügen have been caused by the sheer force of an ice-thrust, ramming such deposits into the chalk, but, as Professor Boyd-Dawkins remarked, there was no necessity whatever for invoking this agency, and in view of the water-worn condition shown in some of the dislocations, it would seem that the cavities or fissures were caused by earth-movements, aided by the cave-forming propensities of chalk, some time prior to the formation of the drift.

The Origin of Boulder Clay.

The discussion on Mr. Hill's paper, and another by Professor T. G. Bonney, again brought into sharp contrast the two opposing camps of glacialists, one of which asserts that boulder-clay is undoubtedly the direct product of land-ice, and the other, which asserts with just as little doubt, that this is an impossible solution of the question. Mr. H. B. Woodward and Mr. Lamplugh both professed their unqualified adherence to the land-ice theory, which, as a matter of fact, has found its way into most modern text-books, whilst Professor Bonney and Rev. Edwin Hill declined to commit themselves to such a view. The former stated that he had asked for years how land-ice could get to England from Scandinavia over the wide and deep channel which contours the latter country, and the best reply he got was that there was a sort of "clearing-house" at the Dogger Bank, or that the channel was post-glacial. He had asked how, if distributed by land-ice, Shap boulders crossed the ice coming from the Cheviots and Scotland, and Arenig boulders crossed those from Criffel and the Lake District, and the only answers ignored the physical properties of ice.

Clay with Flints.

Years ago, the now veteran geologist, Mr. William Whitaker, F.R.S., when engaged on geological survey work in Berkshire, was at a loss to understand the deposit of red clayey material which was constantly met with in chalk districts, and which almost invariably contained a large number of unworn chalk flints. In 1864 he propounded a theory, and held that this clay-with-flints, as he then called it, was a residue from the slow solution of the chalk, although he admitted that it included some material derived from the eocene. Mr. A. J. Jukes-Browne, F.G.S., in conjunction with Mr. William Hill, has now made a careful examination of chalk from various zones, in order to establish whether or no it were possible for the deposit to have been obtained wholly from the chalk, a view which appears now to be very largely accepted, and as, indeed, Charles Darwin appears to have thought. In the result, the experiments which have been made show that 100 cubic feet of the *Micraster-coranguinum*-chalk will produce only 1.2 cubic feet of clay, and the solution of the *Marsupites*- and *Micraster-coranguinum*-zones to the extent of 200 feet over any part of the area would only yield clay enough to make a layer 2 feet deep. Lastly, it is shown that the quantity of flints in the upper chalk is so much greater than the quantity of clay, that the natural residue could not form a clay-with-flints. Thus, solution of 100 feet of *Micraster-coranguinum*-chalk would yield a bed of flints about 7 feet thick, and only enough clay to fill up the interstices between the nodules. The experiments practically show that it is impossible to suppose that the clay-with-flints owes its origin to the small amount of clay contained even in impure chalk. There is a difficulty in thinking, on the other hand, that the pipes in chalk, which are filled by this clay, have been filled simply by the falling of tertiary material into holes of pre-eocene formation. That such holes are still extending is an established fact, and, somehow, they become filled by the clay as they extend. I suggest that they become filled by a process akin to infiltration, which leaves the angular flints practically in the same position which they occupied when surrounded by chalk.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

A Curious Hybrid.

THE interesting collection of hybrids at the Natural History Museum has just been enriched by a life-sized sketch in colours of a very remarkable hybrid bred at Didlington Hall, Norfolk. This sketch, the work of the Hon. Florence Amherst, depicts a male bird, the offspring of a curious blending of breeds, inasmuch as its male parent was a cross between the long-tailed Japanese fowl and a Campine hen, while its female parent was a common hen pheasant. The general appearance of this extraordinary bird recalls that of the common hen; there are no traces of spurs, and only an indistinct comb, while the tail is short and square. Round the eye is a large vermilion area of bare skin, derived from the pheasant, and similar evidences of pheasant blood appear in the dark blue neck and bright chestnut underparts. Thus this bird exhibits the female characters of its male parent and the male characters of its female parent.

Mediterranean Shearwater in Sussex.

At the last meeting of the British Ornithologists' Club an example of the Mediterranean shearwater (*Puffinus kuhli*) was exhibited, which had been picked up dead on Pevensey beach in February last. This makes the first occurrence of this species in Great Britain.

King Eider in Orkney.

Mr. Fred Smalley, in the "Zoologist" for March, records the fact that an adult female king eider (*Somateria spectabilis*) was killed at Graemsay, in February, by Mr. S. Sutherland, of that place.

Pacific Eider in Orkney.

In the *Field*, April 7, Mr. H. W. Robinson records the occurrence of "another so-called Pacific eider (*Somateria v-nigrum*) in Orkney, making the third this winter," and remarks that "all these three drakes with the V-mark on the throat are probably common eiders." The fact that this peculiar mark is by no means rare in the common eider is one of considerable interest, and until recently was never suspected. But the Pacific eider is generally regarded as further differing from the common eider in that the feathers of the lores in the latter extend so far forward on to the beak that the distance between its furthest point and the extremity of the naked angle on the side of the forehead is greater than the distance from the same point and the tip of the beak, while in the Pacific eider the distance from this point to the bare forehead angle is less than that between this point and the tip of the beak.

Arrival of Summer Birds.

The arrival of the following species has already been recorded:—

Honse martin—Tenby, March 19 (*Field*, March 31).
Sand martin—Wickham, Hants, March 23; Hythe, Kent, March 22.
Willow wren—Eastbourne, March 21; Flax Bourton, Somerset, March 23.
Chiff-chaff—Mitcham, March 17; Bedford, March 18; Salisbury, March 22; Chichester, March 24.
Wheatear—Richmond Park, March 6; Marazion, Cornwall, March 11; Weston-Super-Mare, March 14.
Tree pipit—Ashby Pastures, Leicestershire, March 30.
Redstart—Eastbourne, April 2.
Turtle dove—Aldringham, Suffolk, April 2.

PHYSICAL.

BY ALFRED W. PORTER, B.Sc.

On the Effect of High Temperature on Radioactivity.

EXPERIMENTS made by Curie and Danne (Comptes Rendus, 1904) indicated that the rate of decay of radium C can be altered by subjecting it to temperatures above 630° C.

H. L. Bronson more recently made experiments from which he came to the opposite conclusion.

The question is a very interesting and important one, for one of the main characteristics of the emanation itself is its indifference to the circumstances in which it is placed; hot or cold its rate of decay seems to be absolutely unchanged; and indeed this is one of the links in the chain of evidence by which it was concluded by Rutherford that the change that proceeds is not of an ordinary chemical type—for the temperature has a great influence on every chemical reaction—but is ultra-atomic in nature.

In order to obtain further evidence Mr. Walter Makower (Harling Fellow of the University of Manchester) has recently made a series of observations on the influence of temperature upon the rate of decay of the Beta and Gamma activity of an equilibrium mixture of radium emanation with its products radium A, B, and C. The emanation was enclosed in a quartz tube so that none of the products could escape; while the walls of this tube were so thick that the Alpha streams were also stopped; hence any ionisation produced in the air outside must have been due to the Beta particles and Gamma rays. The tube was allowed to ionise the air in a testing cylinder of the usual type, and thus the activity was measured. If sufficient time were given before the tests for the contents of the tube to come into radioactive equilibrium, the subsequent decay would follow the exponential law, falling to half value in about 3·7 days. If at intervals the tube is heated to a high temperature and retested when cool, it is found that there is a temporary fall in the activity followed by a gradual recovery. The curve of decay is now not an exponential curve, but consists of such a curve in which a series of notches or depressions are produced; in other words the recovery is such that the same point of the diagram is ultimately returned to as would have been reached if no intermediate heating had taken place. The inference that can logically be made is that some part of the contents of the tube is modified by the high temperature; the results are *consistent* with the explanation offered by Curie and Danne that the rate of decay of radium C is increased by high temperature. In examining this conclusion it is important to recollect that in the disintegration of the emanation and of radium A and B, no Beta particle is emitted; at least none is emitted with sufficient velocity to produce any ionisation; so that the activity measured is chiefly due to radium C. The interpretation then is that the amount of radium C falls off more quickly at the high temperature, so that when the tube is cooled the contents are no longer in radioactive equilibrium; that is to say, radium C is then produced (from B) faster than it decays: hence it increases in amount, and, if time enough be given, the same equilibrium proportion will be reached as if no heating had taken place. This is a possible explanation (and Mr. Makower only claims it as a possible one); it would be well to test it under conditions in which all ambiguity would be removed. Another explanation would be that radium B broke up *less* quickly at the high temperature, for this would diminish the rate of formation of radium C, and cause therefore a temporary diminution of Beta-activity, the old state of things being gradually returned to on recooling. In any case there now can be no doubt that radioactive equilibrium, as well as chemical equilibrium, is effected by temperature; but the amount of dependence upon temperature is of very different degree in the two cases.

Refractivities of Vapours.

Mr. E. B. R. Prideaux recently succeeded in producing hexafluorides of sulphur, selenium, and tellurium, and has investigated their properties. Their refractivities were determined for him by Messrs. Cuthbertson and Metcalfe by means of an interference method. The interest of the results arises in connection with the possibility of calculating the refractivity of a compound from the values for its constituents by simple addition. It is found that for this series of similar compounds there is no approach to an addition law. The values of the refractivities determined are in the proportion of 783, 895, and 991 on the same scale as that for which the value for an atom of fluorine is 96, of sulphur 540, of selenium 810, of tellurium 1350. The values calculated from the addition law for the three compounds are 1116, 1386, and 1926 respectively; comparison of these with the experimental values shows very marked divergence. The experimental values, on the other hand, are connected with one another by a linear law; that is to say, if these values are plotted against the densities of the vapours to which they relate, the points obtained lie in a straight line. This is the first series that has been examined in this way.

National Physical Laboratory Researches.

Amongst the numerous researches which have been carried out during the past year, we notice a redetermination of the melting point of platinum by Dr. Harker, which is now found to be 1710° C. within five degrees. Some experiments by Holborn and Henning at the Reichanstalt, published in 1905, give the figure 1710° C. also. Thus it seems clear that the value 1780 usually accepted is 70 degrees too high.

An important series of determinations of the calorimetric properties of steam is being made by Mr. Jakeman. After overcoming difficulties mainly concerned with the efficient control of the radiation, he has succeeded in obtaining the specific heat of steam at 4·3 atmospheres pressure, and temperatures ranging from 30 degrees C. to 130 degrees C. above saturation. He hopes now to go on to other pressures and temperatures. The Committee are indebted to the Manchester Steam Users' Association for funds to help with this work.

ZOOLOGICAL.

By R. LYDEKKER.

Hairs in Amber.

THE insects preserved in amber have long since been carefully studied and described, with the result that in most cases they have been found to approximate very closely to living types. A new feature is, however, the discovery of hairs of mammals in this fossil resin which have recently engaged the attention of a German naturalist. So far as can be determined, such hairs as have at present been examined appear to belong to dormouse-like rodents, although, as it has not yet been found possible to identify them with those of any known genus, it has been suggested that they indicate an extinct ancestral type. Assuming their describer to be right in this view, it is satisfactory to find that he has not considered it necessary to give to the hypothetical rodent thus indicated a distinct name; and it is much to be hoped that the same course will be followed by his successor in this line of research. For if dormice or other mammals were named on the evidence of their fossilised hairs, there would be no possibility of correlating species thus named with those founded upon the evidence of bones or teeth, with the result that zoological nomenclature would become still further involved without any compensating advantage.

Flying Snakes.

Although the alleged flying powers of certain Malay frogs is now generally considered to be a myth, according to Mr. R. Shelford, who recently read a note on the subject before the London Zoological Society, three tree-snakes from Borneo are stated by the natives (and native testimony has, very generally at least, a foundation of truth) to be possessed of the power of taking flying leaps from the boughs of trees to the ground. The snakes in question, which belong to two distinct groups, are respectively named *Chrysopelea ornata*, *C. chrysochlora*, and *Dendrophis pictus*. In all three of these, the scales on the lower surface of the body are provided with a suture or hinge-line on each side; and by means of a muscular contraction these scales can be drawn inwards, so that the whole lower surface becomes quite concave and the snake itself may be compared to a rod of bamboo bisected longitudinally. By experiments on *C. ornata* it was seen that the snake when falling from a height descended not in writhing coils, but with the body held stiff and rigid, and that the line of the fall was at an angle to a straight line from the point of departure to the ground. In the author's opinion it is highly probable that the concave ventral surface of the snake helps to buoy it up in its fall; as it can be shown that a longitudinally bisected rod of bamboo falls more slowly than an undivided rod of equal weight.

The Largest Frog.

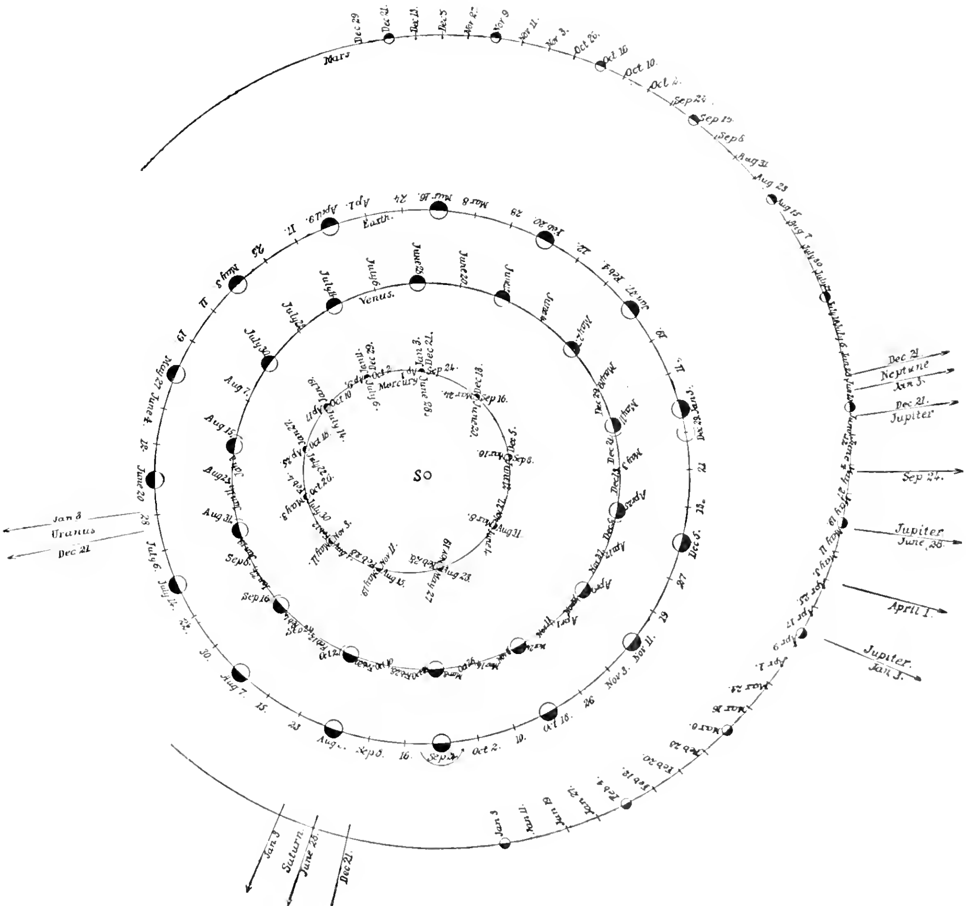
Hitherto the "record" in the matter of size, so far as frogs are concerned, has been held by *Rana guppyi*, a species discovered by Dr. Guppy in the Solomon Islands. The record is, however, now claimed for a species from the Cameroons which has been named *Rana goliath*, whose head and body measure no less than ten inches.

Revival of an Obsolete Name.

Another instance of a perfectly unnecessary attempt to disturb a generally accepted and well-known name is afforded by the proposal that the Japanese deer should be known as *Cervus nipon* in place of *Cervus sica*. It appears that the naturalist, Temminck, gave both names, replacing the first by the second, as being more appropriate. Although such changes would not now be tolerated, it was a common practice among the earlier naturalists, who thought themselves fully justified in so doing. And if this was the opinion and practice at the time, what is our justification for saying that it is illegitimate?

Morning and Evening Stars in 1906.

THE accompanying diagram is designed to aid in the identification of the planets which rise and set before the sun during the present year. The orbits of Mercury, Venus, the earth and Mars, are diagrammatically plotted so as to show the positions of each of these planets at intervals of eight days. The orbits of Jupiter, Saturn, Uranus, and Neptune fall beyond the limits of the page; but since the motions of the last three are limited to very small angular measurements, and that of Jupiter is not more than about one-twelfth of a revolution, the reader will be able, with the assistance of the drawing, to determine approximately the position in the heavens of each of these planets at any assigned date.



Mercury's position is first shown for January 3, and thereafter at intervals of eight days. As this planet's journey round the sun occupies 87 days and $23\frac{1}{4}$ hours, it reaches its first position again, approximately, on April 1, June 28, September 24, and December 21. Since Mercury's revolutions occupy slightly less than 88 days, therefore after four revolutions and a small fraction (352 days), the planet will reach a position which is about half a degree in advance of that occupied on January 3. But to avoid confusion the positions in the diagram are made identical, since for practical purposes the position is sufficiently accurate.

Venus performs her revolution in 224 days $16\frac{3}{4}$ hours; and in the case of this planet, and for the purposes of the diagram, 224 days is regarded as being the interval which will bring the planet to its first position of January 3. Subsequent positions are shown at intervals of eight days, because, by their selection, they may be compared with the positions of Mercury, the earth, or Mars on the same dates. Venus makes about 1½ revolutions in our year; and her second revolution begins on August 15. She is then represented on the diagram by the open circle which falls a little behind that of January 3, and is thereafter represented in a similar manner with the new date attached.

The earth and Mars are also shown at eight-day intervals after January 3. Jupiter's position on January 3 is on the line drawn from S. (the sun); and this planet reaches the positions indicated on April 1, June 28, September 24, and December 21. Similarly Saturn's position is shown for January 3, June 28, and December 21; and the directions of Uranus and Neptune are indicated for January 3 and December 21.

In order to determine the planets which rise before the sun, the reader must bear in mind that the earth revolves on its axis in the direction represented by the arrow (shown at the date September 24). At sunrise the observer emerges from the shadow area. If the drawing be held in such a position that the earth is between the reader and the sun, and he can read the date without turning his head, he will have a correct exhibit of the relative positions of the sun and planets at that date. In this position, if a planet is on the right of the sun, it evidently rises before him. Should the planet be exactly in line with the earth and sun, as, *e.g.*, in the case of Mercury or Venus, if the planet is on the near side, it is in inferior conjunction; if it is on the far side, it is in superior conjunction. If it is at or near conjunction, it will be lost in the sun's rays. At sunset the observer is entering the shadow area. When the drawing is held for a given date in the position above described, if the planet is on the left of the sun, it will set after him. In order to familiarise himself with the use of the plot, the reader is recommended to confine his attention to one planet at a time, and trace its movements relative to the earth and sun throughout the year. For example, if he will revolve the drawing until the earth is between him and the sun for the date January 3, he will read the same date attached to Mercury. Being on the right of the sun, he rises before him. If the drawing be revolved until the date February 20 is reached, Mercury will then be on the far side of the sun, *i.e.*, in superior conjunction. For some time prior to and after this date, the planet will be lost in the sun's rays. After this he will be on the left side of the sun, and will, therefore, set after him. He will be in conjunction—alternately superior and inferior —six times during the year on the following days:— February 20, April 5, June 8, August 12, September 24, and November 30. If the earth were stationary there would be twice as many conjunctions as revolutions, *i.e.*, eight; but this number is reduced by two on account of the revolutions of the earth around the sun.

Mercury will be seen to good advantage after May 3, before sunrise when near aphelion. He will also be seen advantageously in the early evening after June 28, when approaching aphelion. The last position indicated is December 29, when Mercury will rise before the sun.

Venus rises a short time before the sun on January 3, and thereafter. She will very slowly approach superior conjunction, which she will reach on February 14. She will be seen satisfactorily in the evening about the middle of June. Venus will then approach nearer the earth until November 30, when she will be in inferior conjunction. Her dark side will be presented to the earth, and she will be lost in the sun's rays. She will then rise before the sun until the end of the year.

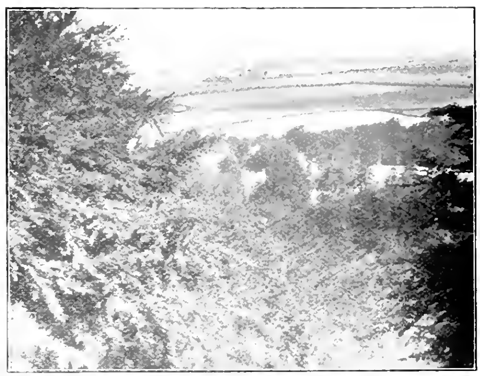
Mars will be visible in the evening before July 15, when he will reach conjunction; and will then rise before the sun for the remainder of the year.

A New Edition of White's Selborne.

By Edward A. Martin, F.G.S., author of "A Bibliography of Gilbert White."

Gilbert White's book, of which a new edition is before us, was published in 1789. Shortly after publication the following remark was made to a nephew of White by Dr. Scrope Beardmore, the Warden of Merton College: "Your uncle has sent into the world a publication with nothing to call attention to it but an advertisement or two in the newspapers, but depend upon it the time will come when very few who buy books will be without it." This prediction has been wonderfully fulfilled, and in the hundred and seventeen years which have since elapsed there has been an average of one new edition in nearly every year.

The new edition which Mr. Charles Morley has



Selborne: View from the Hanger. The tower of the church and the roof of Gilbert White's house immediately in front of it, are just visible.

arranged is called a "naturalist's edition," and from the point of view of the modern systematic naturalist the new arrangement which he has adopted is undoubtedly justified. The whole of White's book has been cut up and classified under headings such as "Meteorology," "Insects," "Birds," &c. Perhaps I may be pardoned remarking that the idea occurred to me some years ago, but I abandoned it as likely to result in a book quite out of keeping with the spirit of White's work. One cannot deny that White was here and there guilty of inaccuracy, or that his conclusions were sometimes at fault, and for these very reasons each succeeding naturalist who edited the book found it necessary to add annotations correcting where it was necessary. Yet in spite of the fact that editors found this necessary, even in some cases adding notes which, in extent, were at greater length than White's own re-

The Natural History of Selborne, by Gilbert White. Naturalist's Edition, classified by Charles Morley. Pages 259, and Index. 6s net. Elliot Stock.

marks, the popularity of the work has never waned. If it were merely in respect of its value as a natural history work that it has attained and maintained its high classic status, then we should expect at least to find greater accuracy and greater systematisation in it. Pennant, one of his correspondents, issued valuable natural history works, but these have been quite superseded by more modern works. Why, then, this phenomenal success of White's "Selborne"? Certainly not as a natural history book, although in the condition of nature knowledge at the time of publication that may have been then its chief attraction. There is something more in it than mere natural history, and it is this—the soul of the work—which, in the present edition, has perforce been left out of account. We do not recognise White in this re-arrangement. The same feelings do not inspire one in reading this edition. Of necessity the blending of one paragraph into another is absent. There is a disjointedness which grates on one's feelings when one has the original in one's mind. So it has been called wisely, as I think, the naturalist's edition, although I fear even naturalists will feel that certain explanatory or amending notes would have made it more readable and reliable.

Leaving aside, however, White's own personality and the charm of the connected series of letters, there are certain advantages in this re-arrangement which one would not wish to overlook. It was somewhat daring of Mr. Morley to cut up a classic work as he

Cottages in Selborne Street, raised above the level of the road, which has been lowered by the "fretting down of ages," as in the case of many of the hollow lanes around.

has, but at the same time the result will be extremely useful to those who, having an edition at hand with the arrangement of the letters as in the book when it left White's hands, desire to know all that the author had to say on some given topic. We have all wasted a good deal of time when wishing to look up some particular passage of White's in not being certain in which letter to find it. In this edition not only are kindred passages brought together, but the marginal references indicate the numbers of the letters of which they formed portions.

There has been difficulty in allocating certain passages to the headings provided for the chapters. This is referred to in the author's preface, and is clear on perusing the book. Probably no one's arrangement would agree with that of another. But one would think that the references to the formation of the chalk downs should have been placed with the geological notes, as also those dealing with the theory of an isthmus across the Atlantic, upon which White pours so much scorn. Why, also, is the reference to the letters in which are printed White's monographs on the *Hirundines*, which formerly appeared in the "Philosophical Transactions," not placed under the heading of "Birds?"

One point which is brought out strongly by this edition is that White was before all things a student of birds. Although the extracts run only into 259 pages in all, no less than 134 pages are given to birds, the subject most nearly approaching to it in extent being meteorology, which claims but 30 pages, after which come the mammals, with 21 pages. Botany has 10 pages, but three of these are scarcely botanical, as they deal with what White calls a matter of domestic economy, namely, the use of rushes for making rushlights, and how the housewives who were careful eked out their scanty incomes.

The only other re-arrangement of the letters which has hitherto been attempted is that which was first accomplished by Sir William Jardine in 1833, in whose edition both series of letters are classified according to date, those to Pennant being interposed amongst others of similar dates to Barrington. This arrangement of the letters was followed in later editions by Captain Thomas Brown in 1833, and Edward Jesse in 1851, but Jardine in 1853 reverted to the original arrangement of the letters. Buckland, however, in 1875 adopted the chronological arrangement of the letters. Now we have a fresh classification under subject headings. It fills a vacant space, and all lovers of Gilbert White will no doubt make an acquaintance with it. It will remain a companion rather than a substitute for the older and original arrangement.

Artificial Rubies.

The synthetic diamond is so small and the expense of making it comparatively so great that it is not likely to compete with the crystal made in Nature's laboratories. That is not quite true, however, of the artificial ruby, which can now be made of a "commercial" size, though examination under a lens will usually reveal its inferiority to the real article. Small crystals of a silicate of alumina coloured by bichromate of potash have been made for the last 15 years, and a method has been found of increasing their size by "nursing" them, or, in other words, by keeping the crystal in the mother liquid till it grows larger by aggregation. The small ruby to be "nursed" is placed on a turning-plate, where by means of an oxy-hydrogen blowpipe it is raised to a temperature of about 1,800 deg. Centigrade. Then with a pair of pincers there are added to it successively tiny grains of artificial ruby. If the work is carried on uninterruptedly without losing sight of the crystal dexterous handling makes it easy to get fine crystals, all of whose parts, though not of homogeneous origin, are melted together and recrystalised into a single form, which may be cut like a natural crystal. One of the difficulties of the work is that the crystals often break while cooling, and one of the defects of these manufactured crystals is the presence of air bubbles which can be detected by a microscope.

REVIEWS OF BOOKS.

ASTRONOMY.

"Der Bau des Fixsternsystems" (The Structure of the Stellar Universe, with Special Reference to Photometric Results), by Dr. Hermann Kobold. Braunschweig. F. Vieweg and Sohn: 6m. 50., pp. xi. + 256, with 3 plates and 19 figures in the text).—This is Vol. XI. of the "Wissenschaft" series of monographs on natural science and mathematics, and must not be regarded as a work of imaginative philosophy. It is an exhaustive collection of methods and results connected with the subject of stellar and solar motion, by no means confined to the photometry emphasised in the title. This is fortunate, for the underlying assumption in the ordinary photometric method is that brightness and distance are in something like inverse ratio as a rule, and to this the known exceptions are so numerous as to throw great suspicion on the method. Some forty pages are devoted to instruments and methods of observation, the determination of positions, brightness, colour, spectral type, parallax, proper motion, radial velocity, and distribution of stars, with different light-scales, colour-scales, and spectrum classification, very little being omitted. Then come about 120 pages of separate results, similarly divided and equally complete, from Ptolemy and Al Sufi to the twentieth century, with photometric comparison of catalogues, distribution of spectral types, a very interesting table of 43 stars, with parallax greater than 1-20th of a second of arc, giving their computed absolute brightness on a scale in which Sirius is represented by 1000, the sun by 34, Vega and Capella by more than 4,000, and α Crucis by about 5,000, and a long section devoted to the solar motion, with a chart showing the results of more than a score of different determinations of the apex, including two by the author, the first of which has been shown to be quite unjustified, the second depending on determinations of radial velocity. It must be admitted that nearly all recent work on this subject emphasises the idea that although the solar system is almost certainly moving towards a point not very far from the direction of Vega, yet the actual result of investigation is far from satisfactory, inasmuch as each different set of stars gives a different position for the apex, *e.g.*, stars of type I. give a different result from stars of type II., bright stars a different result from faint stars, and so on; and although it would seem that stars of large proper motion, or large radial velocity should give a better result, since the effect of small systematic errors is relatively less in their case, yet the material of this character, being at present restricted in quantity, partly nullifies the advantage. Perhaps, when Herr Kistenpart's great catalogue is completed, a discussion of all available material may give a result that will inspire more confidence. The last sixty pages of the book are devoted to the "Bau des Fixternsystems," and special care, as usual, is taken to refer everything to the Milky Way, as the basis of the most obvious and plausible hypotheses. Some good illustrations of the nebulæ are given in this connection, especially a fine copy of Wolf's photograph of the "America" nebula in Cygnus, which figures as frontispiece to the book. At the end we find useful tables, one of 50 stars with well-determined parallax, principally from the work of Gill, Elkin, and Peter, giving the classification according to Pickering and Vogel, and in some cases the radial velocity, and the other of 307 stars with proper motion greater than half a second of arc; which is Porter's list of 301 stars (Cincinnati, Publication No. 14), but corrected and revised, with the addition of six more recent discoveries, including the great southern "runaway," Cardoba, Zone V., 243. Then follow a short bibliography, a useful index, and two large charts of the position of the North and South Poles of the proper motions of the 307 stars in the list. As a monograph on the subject, the work is excellent, but no one need adopt any hasty conclusions from the wealth of material.

"A la poursuite d'une ombre." Travaux et Observations de la Société Astronomique Flammarion de Montpellier. Eclipse totale de Soleil du 30 Aout, 1905.—A young Society, founded only in 1902, with an annual subscription of five shillings (six francs), has been able to send an expedition of ten members to observe the total eclipse of 1905 August 30, at Alcala de Chisvert; a book of nearly a hundred pages embodies the result in the form of chatty reports by Professor Marcel Moye, of Montpellier University, one of the secretaries of the Society. Their equipment, as was natural, was far from elaborate, but from the many lines of eclipse work that do not require such equipment, this Society omitted very few, as they carried out on a small scale the careful division of labour now generally associated with a naval detachment under the direction of Sir Norman Lockyer. In view of the forthcoming volume from the British Astronomical Association, dealing with the same eclipse, we need not look for anything of unique value in the Montpellier results, and the drawings, as reproduced in the work, have a harsh effect, owing to the too great contrast with the background, suffering much in comparison with Hansky's 1896 eclipse photograph, also reproduced in the volume. But as evidence of vitality and enthusiasm in a scientific society, we have nothing but praise for the book.

BOTANY.

The Book of the Rothamsted Experiments, by A. D. Hall, M.A. (John Murray; 10s. 6d. net.)—To every student of agriculture, irrespective of nationality, the mention of Rothamsted recalls to mind the most extended and varied series of experiments, bearing on every branch of agriculture, that has hitherto been, or probably ever will be, attempted. Furthermore, the immense amount of information presented in a concise and methodical manner, representing continuous research extended for over half a century, and presented to the world at large, will for all time serve as a model, and furnish a sound starting-point for future investigators.

The primary object of the book under consideration is to present to the student the chief points of importance, and generalisations suggested by the investigations alluded to; also to indicate the scope and aim of the Rothamsted Experiment Station. The result is an unqualified success. There is nothing in the book that cannot be grasped by the farmer or horticulturist taking an intelligent interest in his vocation, whereas to the student and expert its pages teem with valuable first-hand information, and suggestions for future investigation.

The entire work is founded on a strictly scientific basis, and deals only with fundamental problems, as indicated by the following extract from the preface: "The farmer who visits Rothamsted must not expect to see demonstrations of the most profitable means of growing this or that crop, but rather to obtain information as to its habits or requirements, which on reflection he can make useful under his own conditions."

Of exceeding interest is the chapter on the sources of the nitrogen of vegetation; the researches on this subject conducted by Lawes and Gilbert resulted in clearly demonstrating that the above-ground green parts of plants did not possess the power of fixing nitrogen; on the other hand these experimenters failed to demonstrate the fact that free nitrogen was fixed by bacteria present in the nodules on the roots of leguminous plants. This, however, was not so much due to the fault of the investigators concerned, as to the general apathy towards scientific research in this country. If the necessary knowledge had been forthcoming it would have been utilized. This gap, bearing on bacteriological work has, so far as Rothamsted is concerned, been bridged by the present Director.

The generally accepted idea that whole meal of wheat grain is the most nutritive food is fully dealt with, and shown to be wrong.

From scattered remarks it is gathered that an excess of nitrogenous manure favours the attack of fungus parasites.

A very interesting biographical sketch of Sir John Bennet Lawes and Sir Joseph Henry Gilbert, the founders of the Rothamsted Station, is given.

CHEMISTRY.

Qualitative Chemical Analysis (Organic and Inorganic), by F. Mollwo Perkin, Ph.D. (Longmans, Green & Co.: vi. + 308 pp., $5\frac{1}{2}$ + $8\frac{1}{2}$, 4s., 1905).—The author, who recognises the fact so familiar to teachers of chemistry that students too often completely separate their theoretical knowledge from their laboratory experience, has endeavoured in this manual of qualitative chemical analysis to supplement the practical instructions by sufficient explanatory data to arouse in the learner an intelligent interest in the operations under discussion. In these theoretical explanations the author has made judicious use of the ionic theory, employing it where the earlier views are incomplete or misleading, but retaining the older mode of representing double decompositions when this formulation indicates with sufficient accuracy the reactions taking place in the various analytical tests. The chapter on reactions in solutions and the paragraph relating to the solubility of magnesium hydroxide in ammonium chloride are cases in point. The inorganic section of the book deals very fully with the reactions of the ordinary metals and acids and contains also the distinctive tests of certain rarer metals and less common acids. The author states in the prefaces to both editions of the work that only those reactions are included which have been experimentally verified. At the risk of adding to this practical revision, we venture to suggest a few instances in which a little additional information might be imparted without materially increasing the size of the volume.

Among the tests for bismuth no mention is made of the action of reducing agents; the interaction with alkaline stannites is, however, of some interest, having been recently the subject of a controversy concerning the alleged existence of bismuth suboxide.

The statement on p.69 that "the solutions [of chromium salts] are violet or green depending on their concentration" does not sufficiently take into account the effect of temperature on the colour and constitution of these dissolved salts, and of the tendency for the cation Cr to form complex ions with certain anions, such as SO_4 for example.

Our experience is that the separation of the sulphides of manganese and zinc from those of nickel and cobalt by means of cold dilute hydrochloric acid is not always reliable, and hence it might be well to give at least a brief reference to the alternative method in which the four sulphides are dissolved simultaneously, the separation being then effected by successive treatment with caustic soda, hydrochloric acid, ammonium acetate, and sulphuretted hydrogen.

The acidified permanganate process for detecting chlorides in presence of bromides and iodides is a useful alternative method to those indicated in the text, and the only distinctive test given for bicarbonates might be supplemented by a reference to the behaviour of these substances towards phenolphthalein or mercuric chloride.

The organic section contains a useful chapter on "elementary" organic analysis in which a note should be introduced pointing out the danger of employing the sodium or potassium test for nitrogen with nitro-compounds of the picric acid type. The remaining chapters deal with the reactions of representative examples of the chief groups of organic derivatives. The sections on alkaloids, carbohydrates, and organic acids merit special mention as the range of examples is very extensive, and many quite modern tests have been incorporated. Whenever possible, these organic reactions have been tabulated, a system which facilitates comparison and tends to render the practical work more systematic.

Full particulars for the preparation of the reagents required in both inorganic and organic sections are given in the appendix.

Although a few trivial clerical errors still persist (*e.g.* pp. 184, 210), the present edition bears the marks of careful revision, and the author is to be congratulated on the large amount of useful information which he has condensed into a convenient bulk. On this account the work may be regarded not only as an up-to-date laboratory manual, but also as a serviceable book of reference on analytical chemistry.

ETHNOLOGY.

The Twenty-Third Annual Report of the Bureau of American Ethnology (Government Printing Office, Washington).—When we take up a large and handsome volume of over 600 pages and find that, in addition to many smaller illustrations, there are no less than 139 excellent plates, mostly coloured, within it, we can but wonder whether so splendid a work is worth all the trouble bestowed upon it. This, of course, entirely depends upon the subject, which in this case is confined to an account of one tribe of American Indians. The Zuni Indians: Their Mythology, Esoteric Fraternities, and Ceremonies, are described in the fullest detail by Mrs. M. C. Stevenson. This tribe inhabits districts in New Mexico and Arizona and is one of great interest. "They look to their gods for nourishment and for all things pertaining to their welfare in this world, and while the woof of their religion is coloured with poetic conceptions, when the fabric is separated thread by thread we find the web composed of a few simple, practical concepts." The expedition sent by the Bureau of Ethnology in 1879 to study this district remained at Zuni for six months, and in subsequent years returned again for long periods, so that the work has been very thoroughly accomplished, and apart from the interest of the peculiarities of the tribe, it is a pleasure to see any one subject so exhaustively treated of, and all interested in ethnology and the quaint habits of wild people will welcome this great work with delight.

NATURAL HISTORY.

Our School Out of Doors. A Nature book for young people. By the Hon. M. Cordelia Leigh (T. Fisher Unwin; 2s.). This is a most excellent little guide to everyday knowledge. The various subjects dealt with are included in short paragraphs with clear headings, and a set of questions ends up each chapter, ensuring a mastery of its lessons. A number of good illustrations add to the attractiveness of this practical little book.

SCHOLASTIC.

Elements of Descriptive Geometry, by O. E. Randall, Ph.D. (Ginn and Co., New York; pp. 209). This is a treatise on geometrical drawing, or practical solid geometry, dealing with the projection not only of rectilinear solids, but also of curves and surfaces of single and double curvature. It is intended primarily for students of engineering drawing, for whom it is well suited.

English Composition Simplified, by J. Logan (T. Murby and Co.; 1s. 6d.). Those who wish to have on their table a concise and practical guide to English composition cannot do better than procure this little work, which in unpretentious fashion gives all the more recognised rules connected with it. Nearly half the work, however, is devoted to skeleton and specimen essays, which do not seem, to our thinking, to be of any great practical value.

SOCIOLOGY.

Foundations of Political Economy, by William Bell Robertson (Walter Scott Publishing Co.; 5s.). This work has two aims in view, the one being, we think, rather difficult to reconcile with the other. These are to maintain a "strict adherence to the methods of . . . the orthodox school" in the treatment of political economy, while the other is "to sever from any future connection with it the epithet 'dismal.'" Though we cannot say that the work has caused us any great hilarity, the subject treated of is put clearly and to the point.

MISCELLANEOUS.

Mrs. Beeton's Book of Household Management (Ward Lock and Co.). New edition. This, though hardly to be classed under the heading of scientific works, is thoroughly deserving of notice as a most complete guide to all that pertains to the culinary laboratory. The various methods of analysis incidental to the preparation of bodily nutriments, and the observation of the reactions occurring in the cooking pot are, after all, some of the most important investigations in human life and happiness, and this very complete work should certainly be in the possession of all who take a pride and an interest in their internal mechanism.

Sundials. Messrs. Newton and Co. issue a special catalogue of sundials and pedestals, which they make in every variety, and to suit every position. The sundial has of late years enjoyed a renaissance of popularity, due, no doubt, to the reviving interest in every kind of antique property, from Tudor manor houses to Adams' mantelpieces; and sundials are not the least charming objects of an admirable taste. Those which Messrs. Newton advertise are excellent in execution and design; they enshrine all the old mottoes from "Light rules me, the shadow thee," to the didactic, "Sic Vita, Finis Ita," on old Chelsea Church. Their workmanship, pattern, and design are alike unexceptionable.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 416.)

I HAVE now dealt at some length with the camera and the adjustment of the microscope, and it only remains to add a few words on the photographic process itself. I shall assume that the reader has some experience of ordinary photography, and shall content myself, therefore, with explaining such modifications as are necessary for photo-micrography. Formerly an initial difficulty made itself felt owing to the difference in focus between the visual and actinic rays of an objective, by which I mean that though an object might appear to be in focus on the ground-glass or plate-glass screens when examined visually, the photographic negative when developed was found to be out of focus owing to the fact that the actinic rays were not identical with the visual rays. Owing to the improvement in objectives, however, by which they tend towards apochromatism, and to the use of orthochromatic plates and certain screens, this difficulty seldom occurs now. Therefore possessors of modern objectives will have little trouble on this score, and such objectives may be used either with or without an eye-piece, but in the former case a projection ocular should be obtained, and will give better results. Huyghenian oculars do not perform well in photography. Apochromats cannot be used alone, but perform excellently with their compensating oculars as well as with projection oculars.

There comes in, however, another difficulty. Unless an object has good contrast it is manifest that the resulting photograph will be lacking also in contrast, but what is less evident is that the stains with which microscopical slides are stained may differentiate structure sharply enough to the eye, and yet, owing to the varying actinicity of the colours, fail to differentiate the same structure satisfactorily in the photograph. An ordinary photographic plate, for instance, shows a great susceptibility to the rays at the violet and blue end of the spectrum, and very little to those at the yellow and red end.

If the object were merely black and white this would not be material, but supposing we were trying to photograph a violet or blue object on a yellow ground we should find that the object would impress itself upon the plate as fast as the ground, and there would be no contrast or differentiation. We should, therefore, need to keep back the violet of the object and to assist the yellow of the ground. Our first method of dealing with this is to use an orthochromatic plate, namely, one made either actually or comparatively more sensitive to yellow, and our second method is to use a screen, in this case a piece of dense yellow glass, which will cut off, or, at least, keep back, the violet rays, and so assist the yellow rays to impress themselves upon the yellow sensitive plate. Of course, the treatment will be varied according to the staining, and it might even happen that with a pale yellow object we might need to use an ordinary plate and a blue or green screen, but enough has been said to show the nature of the difficulties besetting the photo-micrographer, and the way to deal with them. Generally speaking, the principle is to keep back the colour with which an object is stained by using a plate which is not sensitive to that colour, and a screen (generally of an opposite colour) which tends to nullify it.

(*To be continued.*)

Royal Microscopical Society.

At the meeting held on March 21, the Rt. Hon. Sir Ford North, P.C., F.R.S., Vice-President, in the chair, the death of Mr. J. J. Vezey, Treasurer of the Society, was announced. Mr. Wynne E. Baxter, J.P., F.G.S., was appointed Treasurer in succession to Mr. Vezey. Mr. J. W. Gordon exhibited and described a new retro-ocular or top-stop for obtaining dark ground illumination with high-power objectives, and increasing the definition of highly-resolved images in a bright field. Mr. C. F. Rousselet read a paper entitled "A Contribution to our Knowledge of the Rotifera of South Africa," illustrated with lantern slides and mounted specimens. Mr. J. M. Coon exhibited and described a new form of finder, which could be used on any microscope, and with high powers, and by which the object registered on one microscope could be found on any other. The Secretary read an abstract of a paper by Mr. N. D. F. Pearce "On some Oribatidæ from Sikkim." A paper by Mr. E. M. Nelson "On the Limits of Resolving Power for the Microscope and Telescope," being of a technical character, was taken as read.

Quekett Microscopical Club.

At the meeting held on March 16, Mr. C. D. Soar, F.R.M.S., gave a lecture on "The Life-History of Fresh-water Mites (*Hydrachnida*)." The life-history may be divided into four stages—ovum, larva, nymph, and adult. Descriptions were given of some of the various methods adopted by different species in depositing the eggs. The incubation period is about 30 days. The development of the embryo was described and illustrated by a series of figures drawn every two days from the deposition of the egg until the emergence of the larva. In the second stage of the life-history the larva usually becomes parasitic, as a rule selecting a host which lives in the water. The insects most commonly infested were mentioned, and several specimens from the genus *Dytiscus* were shown in spirit with a number of the larvæ attached like small bags to the ventral surface. *D. marginalis* was said to be a very favourite host. After describing the nymph stage, the lecturer showed by means of the lantern a number of interesting drawings of adult forms of some of the 60 genera at present known. The life-history of these mites was first described by Müller in 1834.

Mobile Crystallisation.

The *Times*, of January 3, quoting from the *Frankfurter Zeitung* of December 12, has an interesting and suggestive note on a new physical action which has recently been observed in the Physical Institute of the Karlsruhe Polytechnic, a fuller account of which was to appear in the *Annalen der Physik*. It was observed there some time ago that in certain kinds of solutions tending to form emulsions, the existence of extremely soft, almost liquid, crystals was possible, which, under certain conditions, assumed the forms characteristic of solid crystals, cubes, prisms, and the like. In other cases, for instance, when under the influence of protracted cooling, the cohesion, and with it the surface tension, became increased, these bodies might assume the forms of minute spherical drops, like those found in ordinary fluids. More recently, on microscopically examining certain of these drops, it was found that they behaved like living infusoria, and were in such active motion that the eye could scarcely follow them. The drops, which had somewhat the consistence of olive oil, were not absolutely spherical, but they frequently have a funicular depression from the middle of which a ray is directed to the centre of the drop. The drops change very suddenly in form, and assume a serpentine shape. In other cases they appear to bud out or become divided, and give rise to several new particles by a species of spontaneous self-division. The changes which take place are similar to those observed in the case of micro-organisms, but in this instance they are no doubt caused by very slight variations of temperature.

Messrs. Flatters and Garnett's Catalogue.

Messrs. Flatters and Garnett, of Manchester, have sent me a new catalogue which they have just issued. The first part contains a classified list of slides of their own mounting, the majority of which are sold at the very modest price of 6d. each. Amongst these I may mention their excellent Student's Series of Botanical Slides, 48 in all, sold at 21s. the set, or with an explanatory book of diagrams 1s. extra. The second part of the catalogue contains a list of microscopes and accessories by the leading English and Continental makers, and particulars of various mounting and other microscopical requisites. Apparatus for the study of pond-life is particularly well represented, and amongst this are various sizes of rectangular glass tanks, made in one piece, for use with hand lenses, and two neat japanned collecting cases containing corked tubes, so arranged that the tubes cannot be upset when the case is placed open upon the ground.

Microscopical Material.

By the kindness of Mr. J. Strachan, of Ballyclare, Co. Antrim, I am able to offer to such of my readers as care to apply for it some diatomaceous earth from the deposit at Toome, on the river Bann, Co. Antrim. Applications must be accompanied by the coupon to be found in the advertisement pages of this issue, together with a stamped and addressed envelope, and, preferably, by a very small box. It is, perhaps, advisable to mention that I not infrequently receive applications for similar material, which, in spite of clear instructions, are accompanied neither by envelope nor stamp, and to these I feel myself justified in paying no attention.

Notes and Queries.

C. T. D., Hayward's Heath.—A one-sixth inch objective will probably show you most of what you want to see with regard to animal hairs, and for this power a condenser is necessary if you wish the objective to perform at its best. The pigment granules can generally be seen if the hair is a transparent one, but if not you will need to cut longitudinal sections by means of some embedding process. I do not know of any work that has been done on the pigment granules themselves, but a book like Schäfer's "Essentials of Histology," describes human hairs and their follicles with some detail.

T. P. T., Aden.—To distinguish diatoms from Radiolaria, it would be necessary to see them in the living state, or to be sufficiently familiar with the frustule or silicious skeleton of the particular species. The Radiolaria have, for the most part, skeletons quite unlike the frustules of the diatoms, whilst the presence of pseudopodia in a living specimen would at once place it amongst the Rhizopoda. Haeckel's epoch-making work on the Radiolaria is, of course, authoritative, but the best work of reference is the great monograph in the "Challenger" Reports, which contains 1,800 pages and 140 plates, and describes nearly 4,500 species.

S. C. M., Bombay.—A one inch or two-thirds of an inch and a one-sixth of an inch objectives are quite sufficient to examine textile fibres either with or without reagents. An oil-immersion objective would not be suitable for examining micro-chemical reactions, but a one-eighth inch *dry* lens can be used for certain classes of work. I do not know of any "acid-proof" objectives for such work. Personally I keep three special and inexpensive objectives for this purpose, and when necessary affix a small piece of broken cover-glass with glycerine to the front lens, whilst the microscope has a special glass stage. I know of no differential stains for identifying fibres other than those mentioned in my article on the subject—fuchsine would merely stain the fibres and so help to bring out their structure. It is not necessary to fix the fibres to the slip before staining; they can be taken up on the point of a needle and transferred from stain to other reagents as desired and only teased out on the slip prior to mounting. I do not think it would be any use trying to cut sections of fibres unless you have any special reason for doing so, in which case a few fibres could be tied together longitudinally and supported in carrot, pith, or paraffin for transverse sectioning. Nor do I think it would be of service to try to cut sections of paper pulp—it would be a most unsatisfactory job at best, but of course if you wished to do so you could dehydrate in alcohol, clear in xylol and embed in paraffin, or you could embed in celloidin, or even freeze direct with ether.

C. J., Birmingham.—For the use of a polarizer and analyser in ordinary work not connected with the special study of crystallographic systems it is only necessary to have some means of knowing when the Nicol prisms are parallel or crossed, and for this purpose four marks or stops 90° apart are sufficient. It is certainly not necessary to get a polarizing prism large enough to cover the back lens of your condenser. Iceland spar is not only expensive, but the expense increases out of all proportion in the larger prisms. Such a prism would moreover necessarily have a most inconvenient length. I should recommend an ordinary polarizer costing about 20s. or 30s. (with removable selenite), and with a thread in the mount into which you can screw the optical part of your condenser so as to get more light if necessary. The analyser can be mounted either over the objective or over the eyepiece: the former is the cheaper but causes rather more loss of light; the latter is more effective and gives a larger field if of sufficient size. The prism should be removable from the eyepiece. I think you would find Watson's "Universal" Condenser more generally useful than their "Parachromatic," unless you work almost entirely with high powers.

J. B., Kelvinside. I do not know of any advanced book which deals with pond and aquarium life and which would enable you to name objects. Such books are written for amateurs and are necessarily somewhat chatty and discursive. Taking Furneaux's book as a good example of such books, I should say that if you want more detail you must be prepared to study one or more special branches for yourself with the help of special works dealing with such branches; for example, one or more volumes of the Cambridge Natural History or of Prof. Ray Lankester's even more advanced "Treatise on Zoology." You will find the second volume of Carpenter's "The Microscope and its Revelations" of no little service to you in studying microscopic natural history, but I cannot say that it will help you to name many specimens. That, except for the commonest species, is work for specialists.

W. H. B., Leicester. I am sorry that I cannot give you any information as to the mounting of diatoms in realgar. I have some specimens of *Amphipleura pellucida* mounted in this medium, but I believe they were done by one man, who is a professional mounter. Nor do I know of any solvent for realgar which does not decompose it, but it is supposed to fuse easily, and as diatoms will stand a good heat I should look upon this method as offering most probabilities of success. I should be grateful if any of my readers could give any information on the matter, as I have been asked this question before.

Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.

The Face of the Sky for May.

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

The Sun.—On the 1st the Sun rises at 4.35 and sets at 7.20; on the 31st he rises at 3.52 and sets at 8.3.

Sunspots and faculæ are, at this period of solar activity, usually to be seen on the Sun's disc. Several large sunspots have of late been observable on the disc at the same time; prominences also have been conspicuous on the Sun's limb, as shown by spectroscopic observations.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.		Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May	1 ..	24° 26′ W	4° 2′	133 45′
,,	6 ..	23° 30′ W	3° 30′	67 40′
,,	11 ..	22° 22′ W	2 58′	1 33′
,,	16 ..	21° 4′ W	2 24′	295 26′
,,	21 ..	19 36′ W	1° 49′	229 18′
,,	26 ..	17° 58 W	1° 13′	163 7′
,,	31 ..	16° 12 W	0 37	96 58.

The Moon:—

Date.		Phases.	H. M.
May	1 ..	☽ First Quarter	7 7 p.m.
,,	8 ..	○ Full Moon	2 10 p.m
,,	15 ..	☾ Last Quarter	7 3 a.m.
,,	23 ..	● New Moon	8 1 a.m.
,,	31 ..	First Quarter	6 24 a.m.
,,	8 ..	Perigee	7 6 p.m.
,,	22 ..	Apogee	3 6 p.m.

Occultations.—There are no naked eye stars occulted before midnight during this month; on the morning of the 6th at 1.33 a.m., however, there will be an interesting occultation of the double star γ Virginis.

The Planets.—Mercury (May 1, R.A. 0^h 55^m; Dec. N. 2° 47′. May 31, R.A. 3^h 48^m; Dec. N. 19° 20′) is a morning star in Pisces and Aries. The planet is at greatest western elongation of 26° 46′ on the 3rd, when he rises about 4 a.m., or 33 minutes in advance of the Sun, hence the elongation is not a favourable one.

Venus (May 1, R.A. 3^h 48^m; Dec. N. 20° 16′. May 31, R.A. 6^h 25^m; Dec. N. 24° 45′) is an evening star in Taurus, setting about 9.45 p.m. on the 15th. The planet appears very bright in the N.W. portion of the evening sky and may be observed shortly after sunset; the disc is slightly gibbous and has an apparent diameter of 11″. On the evenings of the 11th and 12th the planet will be found in apparent proximity to Jupiter.

Mars (May 1, R.A. 3^h 59^m; Dec. N. 21° 5′. May 31, R.A. 5^h 27^m; Dec. N. 24° 0′) is an evening star in Taurus, setting about 9.20 p.m. throughout the month. The planet may be observed shortly after sunset looking to the north-west, but he does not appear very bright, and is not suited for observation in small telescopes as his apparent diameter is only 3″·8. On the evening of the 15th he appears in the sky about 1° north of Jupiter.

Jupiter (May 1, R.A. 4^h 32^m; Dec. N. 21° 28′; May 31 R.A. 5^h 1^m; Dec. N. 22° 22′) is only available for observation for a short time after sunset, and after this month will not again be observable as an evening star until September. The planet appears in too bright a part of the sky for the satellites to be easily observed.

During the early part of May the three most conspicuous planets will appear close together and near the 1st magnitude star Aldebaran (α Tauri), which, though not a matter of real astronomical interest, forms a rather unusual appearance in the evening sky. The diagram shows the positions on May 11, when the planets are all near together, Venus being the brightest and about 1° to the north of Jupiter whilst Mars is feebly visible about 3° away.

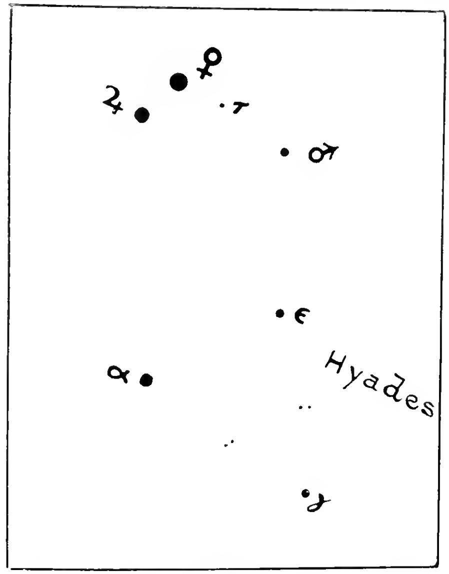


Diagram showing positions of Venus ♀, Jupiter ♃, and Mars ♂, on May 11.

The planets set about half past nine, and the moon, which is full on the 8th, will be rising in the east.

Saturn (May 1, R.A. 22^h 58^m; Dec. S. 8° 23′. May 31, R.A. 23^h 6^m; Dec. S. 7° 45′) is a morning star, rising about 2 a.m. near the middle of the month. The planet is situated in Aquarius.

Uranus (May 15, R.A. 18^h 35^m; Dec. S. 23° 31′) rises about 11 p.m. near the middle of the month. The planet is badly placed for observation, as he is situated low down in Saggittarius.

Neptune (May 15, R.A. 6^h 37^m; Dec. N. 22° 17′) is observable in the north-west portion of the evening sky during the early part of the month; on the 15th the planet sets about 11 p.m.

Meteor Showers:—

The principal shower during May is the *Aquarids*. This may be looked for between May 1 to 6; the radiant being in R.A. 22^h 32^m Dec. S. 2°, near the star η Aquarii.

Telescopic Objects:—

Double Stars.— Libræ, XIV.^{h} 46^m, S. 15° 39′, mags. 3, 6; separation 230″; very wide pair.

σ Coronæ, XVI.^{h} 11^m, N. 34° 8′, mags. 6, 6½; separation 4″·6; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30′, mags. 2½, 6; separation 4″·6. Very pretty double, with good contrast of colours, the brighter component being orange, the other blue.

δ Herculis XVII.^{h} 11^m, N. 24° 57′, mags. 3, 8; separation 17″.

Clusters.—M13 (cluster in Hercules) situated about ⅓ the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a 3 or 4 inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.

Knowledge & Scientific News

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CONTENTS—See page VII.

Astronomical Photography.

Hints to Amateurs Regarding Apparatus and Methods of Working.

By ALEXANDER SMITH.

III.—Development of Plates.

THERE are no operations in connection with photography which admit of such varied methods of treatment as the development of dry plates. When these were first introduced, the available developing agencies were confined to pyrogallic acid and ferrous oxalate of potash, but year after year has added to the number, and at the present time a beginner is well nigh bewildered with the variety of formulæ which he finds set down for his guidance in modern photographic textbooks. In addition to the long list of what may be regarded as standard solutions, platemakers issue special formulæ, which may presumably be supposed to give better results than any other for their particular brand of plates, while the fact remains that for all ordinary purposes a good standard solution will satisfactorily develop almost any reliable bromide of silver plate on the market. Many workers confine themselves to one make of plate, which they develop with a favourite formula, and, where the results are all that could be desired, the best advice that could be given is to adhere to them, as they become acquainted by experience with all their little peculiarities, which they are able to turn to the best advantage. It is not so much a question of using any special developer for the plates of any particular maker, as of *varying the details of treatment for different classes of subjects*. Those engaged at astronomical work have to deal with objects of a very diversified character—from the noonday sun to the faintest class of nebulæ. In the one case the result aimed at is to obtain detail on a brilliantly lighted surface, and in the other the outlines of the merest trace of luminosity projected on a very slightly darker background.

For photographs of the solar image a slow plate should, as already indicated, always be selected, and the same remark applies to lunar and planetary work where the driving arrangements admit of giving the requisite exposure. A developer made up to any standard formula may be employed, but with strongly lighted subjects a weak solution will be found to give more satisfactory results than one of normal strength, the plate being allowed to lie a proportionately longer time in the bath. After carrying out many experiments the writer gives preference to a glycin developer, which has many excellent properties. It is always ready for use with the simple addition of water, and the same solution may be used repeatedly. It does not stain the hands, has no injurious effect on the skin, and keeps indefinitely. It admits of great latitude in exposure, and for all scientific work where it is desired to secure soft and delicate detail it is unsurpassed. It may be used with equal success for the development of negatives, lantern slides, or gas-light papers. It does not, however, possess the vigour of pyrogallic acid or metol, and, consequently, the duration of exposure should always be ample, but, on the other hand, a satisfactory negative can be quite readily obtained, although the normal exposure has been very greatly increased. The point to be kept in view is that the developing agent must be of a suitable strength to take up the work where the action of light left off, and if an exposure of 10 or 20 times the normal amount has been given, a satisfactory negative can be quite readily obtained with a glycin developer by employing a diluted, or, what is, perhaps, more preferable, an old solution which has previously developed several plates. Developing agents, such as pyrogallic acid, do not admit of the same latitude in exposure, and, if toned down by the addition of bromide, the effect is hard and delicate detail is lost.

The following formula, which the writer has used for a number of years, can be confidently recommended:—

Water	18 ounces.
Sulphite of Soda	1,000 grains.
Potash Carbonate	2,270 „
Glycin	1 oz. bottle.

Dissolve in hot water in the order given. When cold the solution should be filtered and put into well-stoppered bottles. For use, add three ounces of water to one of the concentrated solution for ordinary work, and about five ounces of water for lantern slides or gas-light papers. Certain brands of the latter require the addition of a little bromide, but for other purposes it may be dispensed with, or, at all events, used very sparingly. Solutions which have become slower in action after developing a few plates should not be thrown away, as these may be afterwards utilised in cases where the normal exposure can be readily increased, and, as a practical illustration of the keeping qualities of the developer, it may be pointed out that, with the exception of the photographs of Venus, all the plates required to produce the necessary enlargements for the lunar and planetary illustrations accompanying the previous paper were developed with a solution which had been several times used 18 months previously.

In cases where it is desired to secure delicate detail on a plate which has been exposed to a brilliant light, such as that of the sun's disc, and also in cases where the object presents strong contrasts, the plate should be kept in a very weak solution until a faint image is just visible, which will probably require an hour or more. The strength of the developer may then be gradually increased, the requisite amount of density being finally obtained by using a bath of normal strength. The weak solution may be conveniently kept in an old-fashioned collodion dipping bath fitted with a light-proof cover, and afterwards transferred to the usual developing dish, and treated as described. It must be kept in view that no amount of soaking will bring out detail on a plate which has been under-exposed. The exposure in all cases should be ample, and there is, consequently, behind the developer, a reserve of stored up energy, which can be brought into action as required.

With a negative full of detail which is too delicate for the purposes of reproduction, the contrast between the "high lights" and "shadows" may be increased by taking a positive from the negative by contact or by the camera, a much longer exposure than usual being given to a correspondingly weaker light. On the other hand, where less contrast is required, the light is increased and the exposure reduced.

To obtain photographs of faint stars the exposure necessary is so protracted that the methods employed must be such as to secure impressions of the largest number on a given area of the plate in the shortest time, but in the case of stars and diffused nebulosities showing little detail in the shape of structure nothing is sacrificed by having recourse to methods which admit of the exposure being largely reduced at the expense of getting harder effects. For such subjects the most rapid brand of plate should, therefore, be used in conjunction with a vigorous developer. Metol will be found to give cleaner negatives than pyrogallic acid, but if used frequently it sets up an irritating action on the skin, unless the precaution is taken beforehand of rubbing the fingers with vaseline. The following formula has been found to give good results:—

Water	20 ounces.
Metol	75 grains.
Sulphite of Soda ..	10 drams.
Carbonate of Soda (crystals)	14 ,,
Bromide of Potassium ...	8 grains.

The water should first be heated, and the ingredients dissolved in the order given. The keeping qualities of metol are not equal to those of glycin, and a smaller quantity should be made up at a time.

The plate should as far as possible be covered during the entire process of development, which may be continued until the film has very appreciably darkened in colour.

If the negative after being fixed is carefully examined it will frequently be found that in addition to the well-defined stellar points there are numerous impressions of smaller stars which are little more than visible, and are too faint for printing purposes. If by intensifying the negative the density of these faint images can be increased, a result similar to that which would be obtained by increasing the exposure is secured, and if the following method, which differs only in one particular from that given in photographic text-books, is employed, the exposure necessary to bring out a given amount of detail will be reduced by at least one-half, and only those who have spent many a cold winter night at a guiding telescope can appreciate what this means. After the plate has been fixed and thoroughly washed, but *before being dried*, it is bleached in a saturated solution of bichloride of mercury in the ordinary way. It is again carefully washed and placed in 10 ounces of water to which *one* drop of strong ammonia has been added. It should be allowed to lie in this solution for about an hour, when two additional drops of the alkali may be given, and after a shorter interval the strength of the solution may be further increased if the original colour of the film has not been completely restored. If 10 or 15 drops of ammonia are added at the outset, as is usually recommended, the result will be much less satisfactory, a remark which also applies to attempts to intensify a negative after it has been dried.

The accompanying photograph of a portion of the Milky Way in the vicinity of Beta Cygni is reproduced as an example of the amount of detail which may be obtained with an exposure of two hours by developing with metol, and afterwards intensifying the plate in the way which has been described. It was taken with a $5\frac{1}{4}$-inch lens of 22 inches focus, and an examination of the original negative shows that the greater portion of the region embraced by the photograph exhibits large extensions of faint nebulous matter, broken up here and there by well-marked, irregularly-shaped dark channels, which appear to be associated with streams of small stars.

The method of developing and intensifying a plate here referred to is, however, not applicable to strongly-lighted subjects showing structural detail, and more especially when the object is much brighter at one part than at another. The great nebulæ in Orion and Andromeda may be given as noted examples. If forced development is resorted to in such cases with the view of securing impressions of faint stars and outlying wisps of nebulous matter, the image will have become so dense at other parts, which have received a much greater amount of light, that all detail will be effectually obscured. Exposures made on objects of this class should be developed on the lines recommended for solar work, viz., by using a very weak solution at the outset, allowing plenty of time, and gradually increasing the strength of the developer as the image gains in density.

By careful manipulation it is possible to reduce satisfactorily the denser portions of such negatives by the local application of a reducing solution as described in a previous paper, but it is a matter of opinion how far such treatment may be permissible when dealing with objects of a nebulous character, as there is great risk of introducing detail which has no objective existence.

Another method may be employed to which less objection can be taken. A positive may be made from the negative by contact, and after an exposure, suitable for the parts which are less dense, has been given, a piece of cardboard, with an aperture somewhat smaller than the dense part of the film, is placed over the negative, which is then exposed a second time to the source of light, care being taken that the cardboard is kept moving during the operation, otherwise the shadow of the aperture would appear on the plate. If the dense part of the image increases gradually up to the centre a third exposure may be given with a screen having a smaller opening. From the positive thus obtained another negative may then be taken.

NORTH

Photograph of the vicinity of Beta Cygni, taken by Alexander Smith. Exposure two hours.

ENLARGING.

If astronomical photography is to be seriously engaged in, provision must be made for enlarging the original negative, in order that the details of small objects may be shown on a larger scale. The usual method of projection by a lantern is unsuited for delicate astronomical work, and an enlarging camera, similar to that shown in dealers' catalogues, should be employed. These are provided with a long bellows body having a division at the centre for the support of the lens. The front portion should be fitted with carriers suitable for the various sizes of plates there may be occasion to use. The other end should be provided with a focussing screen of a suitable material, and a dark-slide with carriers to take whole, half, and quarter plates. Almost any lens which gives a perfectly flat field when stopped down may be employed. The negative should be covered with a piece of ground glass to diffuse the light, and the whole arrangement placed in front of a window. Slow plates should be used, and it is strongly recommended that these be developed with glycin as previously described.

If the enlarging operations can be carried out in a dark room a camera may be dispensed with altogether. Under such circumstances it will only be necessary to place the negative in an opening in the window, while a baseboard with a support for the lens, and another for the plate, or paper, as the case may be, is all that is required in the shape of apparatus.

Further details need not be entered into here, as these may be found in any photographic text-book, but there is one feature in connection with enlarging, which may be brought under the notice of those engaged in scientific work. If it is desired, for example, to enlarge a small image up to, say 16 diameters, and if this is done at one operation, the grain of the plate will be so obtrusive that there may be a difficulty in some cases in mentally separating the objective details of the image from effects which are spurious. No silver image will bear direct enlargement to the extent in question, and to get the best results this should not be carried further than two diameters at one operation. Four exposures are, therefore, necessary, a positive and negative image being used alternately. The advantage of this method will be at once apparent. Instead of spreading the original image over an area 256 times in extent, a fresh [illegible] with the requisite amount of density is obtained at each exposure.

The Gypsy Moth in America.

[illegible] instance of the adjustment of a newly introduced pest [illegible] surroundings is reported in the last proceedings of the [illegible]gical Society of Washington. In the year 1868 some breeding [illegible]ments were being made in the Washington Laboratory with [illegible] "gypsy moth." By some accident an "egg mass" [illegible] in fact. The consequence was that in the next [illegible] Massachusetts found itself faced with a gypsy moth invasion. [illegible] in fighting the insect, the State of Massachusetts [illegible] the task, and the moth immediately began again [illegible]. Last year the State appropriated another £[illegible]0,000 to be spent during the following three years in a new scientific [at]tempt to stem the ravages of the moth. Of this sum £2,000 is being spent in the introduction of the parasites which in Europe [illegible] on the moth, and from Sardinia 2,500 parasite-infested larvæ [illegible] been introduced. Developments are now being anxiously [illegible]. The gypsy moth is attacked by American parasites, but [illegible] to be able to deal with them better than with the [illegible] varieties, and its own vitality is greater in the New World than [illegible] Old.

The Royal Society Soiree.

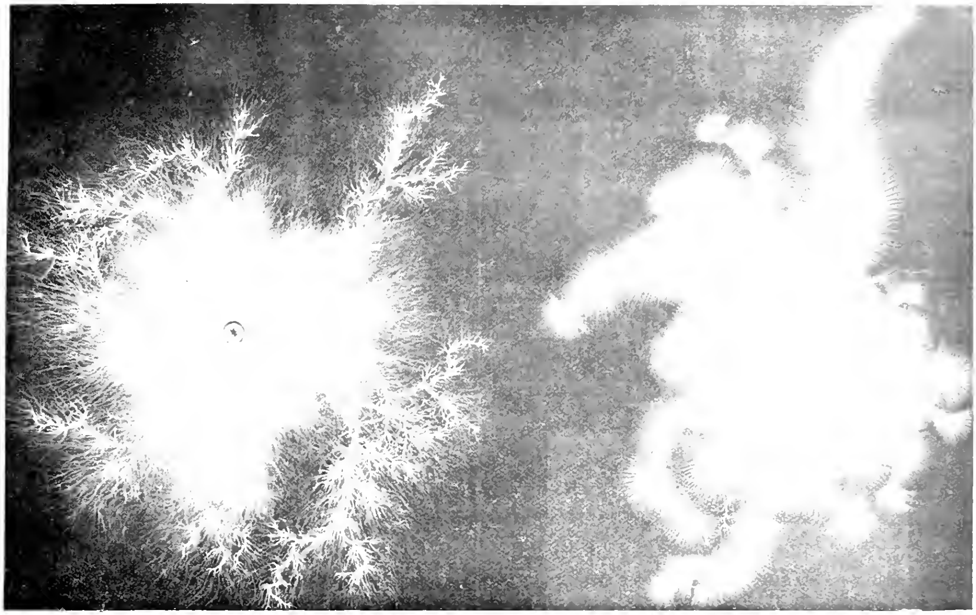
THE first of the two scientific soirées annually given by the Royal Society in their apartments at Burlington House was held on May 9 last, and attracted a representative gathering. The programme of exhibits, embracing as it does on these occasions something from practically every department of science, marking either novelty or progress is, naturally, of too extended a character to permit more than a brief notice. Allusion may, however, be made to a few specially noteworthy features, while we are privileged at the same time to provide the welcome supplement of a selection of illustrations.

The astronomical exhibits were particularly interesting and admirably shown, the use of the "linolite" system of electric lighting being effectively drawn upon to illuminate the series of transparencies. Father Cortie, of Stonyhurst, sent his photographic plates illustrative of the total solar eclipse of 1905, August 30, taken at Vinaroz, on the coast of Spain. In these the chief features are the striking group of prominences, the arches and a vortex ring over the prominences, bright rays and streamers, and a dark ray and plumes; the latter seem to converge to a position previously the seat of the great sun-spot of February and March, 1905. Eclipse results were also furnished by the Astronomer Royal and Sir Norman Lockyer. The Royal Astronomical Society sent six splendid photographs of the Milky Way galaxy, taken last year by Prof. E. E. Barnard at Mount Wilson, California.

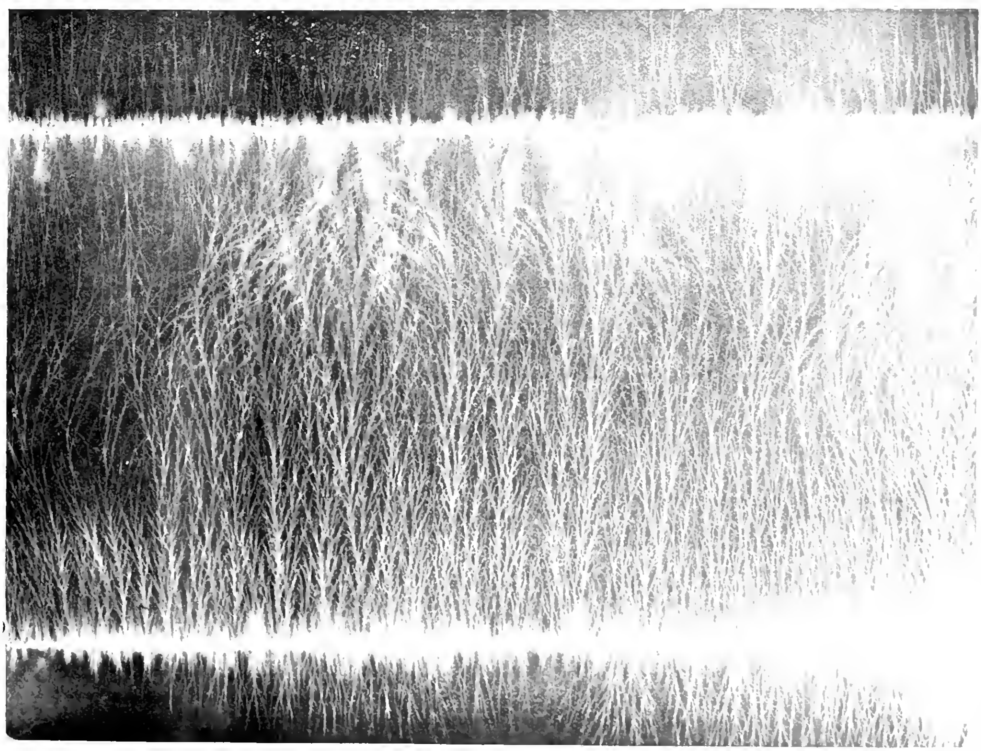
In the department of electricity Mr. Kenneth J. Tarrant's set of photographs of electric discharges at atmospheric pressure and *in vacuo* attracted much attention. In these were seen the results obtained from an interrupted continuous current, and from a high frequency oscillating one, also between parallel conductors, both insulated and bare; of varying capacity and with various condenser conditions. The spiral formation of high frequency discharge, and the same feature in a vacuum a little short of that necessary for the Röntgen phenomena was clearly shown in some of the photographs.

The first of the two photographs reproduced here shows a simultaneous discharge from both poles of a 10-inch coil on to the same plate, the current through the primary being reduced so as to keep the discharge within the limits of the plate. Here is presented the final result of a number of experiments under various conditions, to ascertain whether the marked difference observed in the character of the figures obtained from the two poles of an induction coil was real, or only due to the static induction of the photographic plate itself, or other varying conditions. The second photograph shows an oscillating discharge from a non-magnetic transformer, between two parallel wires of equal size. A spiral twist along the lines of discharge apparently indicates rotation.

Mr. Julius Rheinberg's exhibit of photo-micrographs taken by Dr. A. Kohler with ultra-violet light by means of his specially designed Zeiss apparatus, was of great interest, as well as the allied demonstration by Messrs. Beck, Ltd., of the ultimate microscope resolving power with light of different wave-lengths. For the diatom specimen which was shown in exemplification, a 1-12th-inch oil-immersion objective was used. The beam of a Nernst lamp was split up into a



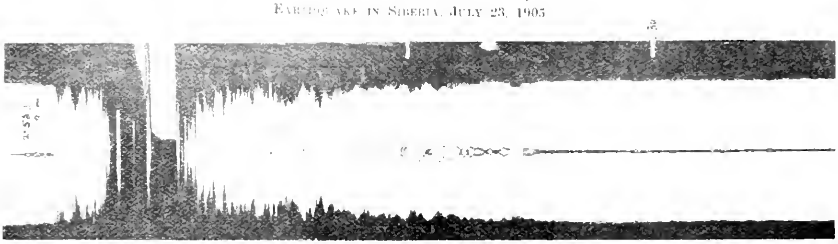
Simultaneous discharge from both poles, showing characteristic figure attached to each.—



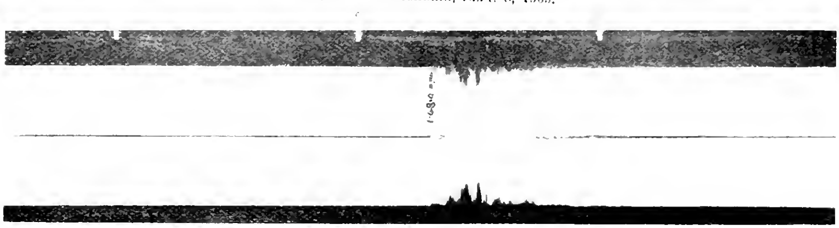
High f

Indian Earthquake, April 4, 1905.

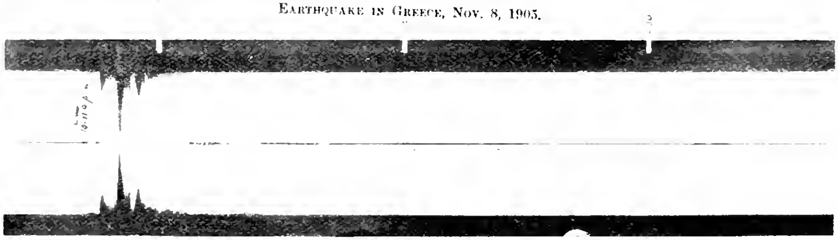
Earthquake in Siberia, July 23, 1905.



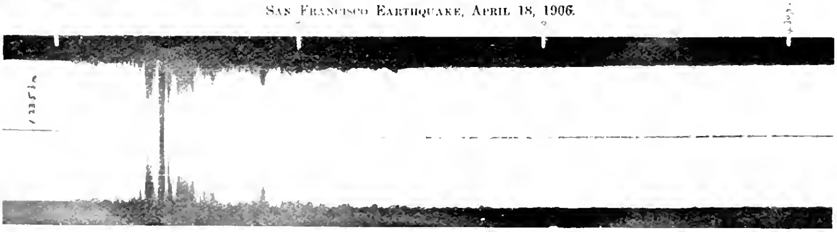
Earthquake in Calabria, Sept. 8, 1905.



Earthquake in Greece, Nov. 8, 1905.



San Francisco Earthquake, April 18, 1906.

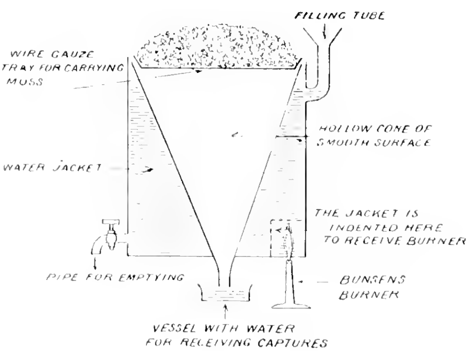


By permission of Prof. Dyson, F.R.S.

brilliant spectrum by means of a Thorp replica grating, the rays of any portion of the spectrum becoming in this way available for the illumination of the object. As the result, whereas the detailed structure of the diatom was revealed with green light, this was not the case with yellow light.

From Prof. J. Milne, F.R.S., and Prof. F. W. Dyson, F.R.S., of the Royal Observatory, Edinburgh, came seismograph records of recent earthquakes, affording suggestive comparative material for the discussion of seismograms relating to the Formosan, Columbian, and San Franciscan earthquakes of this year, as well as of four disturbances occurring in 1905. Two diagrams of the Columbian earthquake, which Prof. Milne showed, had been, it is of interest to note, recorded with a pendulum, weighing in the one case 80 lbs., with a period of 25 seconds, in the other the weight was only a few ounces, with a period of 15 seconds. Both had recorded the period for the large waves as 17 seconds. According to this observer, in the 13 years' interval, 1892-1904, there are records for at least 750 "world-shaking" earthquakes, which may be referred to three periods continuous with each other, and each two-tenths of a year or 73 days' duration.

In natural science the Marine Biological Association were responsible for a small collection of living fishes from the shore and shallow water, illustrating the differences in habit and mode of life adopted by different species. On behalf of Prof. Antonio Berlese, occupant of the chair of Zoology in the University of Naples, Mr. Cecil Warburton brought the former's ingenious



apparatus for capturing minute insects, the action of which is seen in the accompanying section diagram. The hollow metal cone is bounded by a water jacket; on the open base of the inverted cone rests a tray made of wire gauze, designed to carry moss or any other material which forms the natural harbouring quarters of small insects. If the water in the jacket is maintained at a temperature of about 70° Centigrade the tiny denizens prefer to quit the moss, but since no footing is obtainable along the sloping sides of the cone they fall into the glass receptacle placed at the apical end of the cone. From there they can be transferred to a dissecting microscope, if required, for identification or examination. Mr. Stanley Gardiner and Mr. H. P. Thomasset's fine series of enlarged photographs of the vegetation of the Seychelles indicated the sharply divisible character of the flora due to soil characteristics.

The Stellar Universe.

By J. E. GORE, F.R.A.S., M.R.I.A.

THAT our *visible* universe is limited in extent there is abundant evidence to show. The number of stars visible to the naked eye is not only comparatively small, but absolutely so; and the number which will appear on the photographic charts of the sky, now in progress, will probably not exceed 100 millions. And even this large number is comparatively small. The richest man in the world is said to possess as many sovereigns; and in a ten-acre field of ripe oats the number of grains of corn probably exceeds the number of the visible stars.* Taking the population of the earth at 1,500 millions, we have the remarkable fact that for every star in the sky there are 15 human beings living on our little globe.

The number of stars visible to the naked eye has been variously estimated. The photometric measures made at Harvard Observatory show the following figures:— Under magnitude 2, 38 stars; under 3.0, 99; under 4.0, 317; under 5.0, 1,020; and under 6.0, 2,865; total 4,339 to the 6th magnitude. The coefficient of increase for each magnitude is about 3; that is, the total number down to any given magnitude is about 3 times the number of all stars brighter than that magnitude. Professor Newcomb thinks that there is no evidence of decrease in this coefficient down to the 10th magnitude. But a diminution in the rate of increase must set in somewhere below the 10th magnitude, for otherwise the number of the visible stars would be considerably greater than it actually is. Taking the total number of stars to magnitude 6.0 as 4,339, and allowing a factor of 3 for the total number to each magnitude below this, I find that the total number down to the 15th magnitude should be about 85 millions, to the 16th magnitude about 256 millions, and to the 17th magnitude—about the faintest visible in the great Yerkes telescope—about 768 millions. It is evident, therefore, that there must be a diminution, or "thinning out," of the visible stars at some point in space. This diminution in the increase probably begins with stars of the 10th or 11th magnitude. Now what is the cause of this decrease in number as the stars become fainter? Is it due to an actual decrease in number as we approach the limits of the visible universe, or is it caused by an extinction of light in the ether of space? The latter seems improbable, for Professor Seeliger finds that stars of the 11th and 11½ magnitude are comparatively few in number near the poles of the Milky Way, but are very numerous in the Galaxy itself. This is also true for fainter stars, such as those seen by Sir William Herschel in his "gages." Photographs give similar results. Dr. Roberts' photograph of the Milky Way in Cygnus shows about 8,500 stars to the square degree, while a photograph taken near the North Galactic pole shows only 178 stars to the square degree, the average for the whole sky being about 2,500. It seems reasonable, therefore, to conclude that if faint stars are apparently few in number near the poles of the Milky

* This I have found by actual experiment on the number of grains on a square foot.

Way, the real reason is that the stars are *not there*, and that in this region, at least, there is a real "thinning out" of the stars at a certain distance from the earth. It is clear that if absorption of light by the ether had any real, or, at least, appreciable, effect, it would have the same effect in the direction of the Milky Way as in that of the Galactic poles. We must, therefore, conclude that the paucity of stars near the poles of the Milky Way indicates that the stars are really few in number in that direction, and that here, at least, the visible universe of stars is limited. And it seems highly probable, and, indeed, we may say certain, that even in the direction of the Milky Way itself the stars thin out beyond a certain distance, and do not extend indefinitely into space, for if they did, the Milky Way would be much brighter than it is.

Now let us consider what is the probable extent of the visible universe. The faintest stars visible on photographs are probably about the 18th magnitude; that is, about one magnitude fainter than the faintest visible in the Yerkes telescope. Assuming this magnitude, and taking the sun's stellar magnitude as -26.5, I find that to reduce the sun's brightness to that of these faint stars it should be removed to a distance represented by about 12,500 years of light travel. The sun, if placed at the distance of Sirius (parallax $= 0''.37$), would shine as a star of about 2.22 magnitude, or 3.8 magnitudes fainter than Sirius appears to us. From this it follows that Sirius is about 33 times brighter than the sun. Sirius might, therefore, be removed to 5.75 times ($\sqrt{33}$) its present distance and still shine as a star of 2.22 magnitude; and to reduce it to a star of the 18th magnitude it should be removed to 8,241 times its present distance. This would represent a light journey of about 72,000 years. If, therefore, any of the 18th magnitude stars in the Milky Way are suns similar to Sirius, that is, of the same size and intrinsic luminosity, they may lie at a distance of 72,000 years of light travel from the earth. That is, provided that light suffers no extinction in traversing this vast distance. And if similar to our sun, they may be at a distance of over 12,000 years' journey for light.

There seems to be evidence, however, that the greater portion of the light of the Milky Way does not come from these faint stars, but from stars considerably brighter. Mr. C. Easton finds from an examination of a photographic plate of a very brilliant region of the Milky Way to the south of the bright star γ Cygni (a region including 25 Cygni), that about half the total light of the Milky Way in this region comes from stars of the 9th to the 12th magnitude. From this he concludes that neither the bright telescopic stars (6th to 9th magnitude) nor the very faint stars (12th to 14th magnitude) have any great influence in producing the light of the Galaxy. From an investigation of a much fainter portion of the Milky Way he finds the same result.* This agrees with my own computations of the total brightness of starlight, which show that the maximum amount of light comes from stars of the 9th to 12th magnitude.† From further investigation Easton thinks it "extremely probable that the great majority of the fainter stars of the Milky Way—so far as their existence is revealed to us by photography or direct vision—are not much more distant from us than the stars of the 9th or 10th magnitude, at least, in the regions to which our researches have extended."‡

Professor Newcomb thinks that there is evidence to show that the stars of the Milky Way are probably situated at a distance between 100 million and 200 million times the sun's distance from the earth. These distances correspond to 1,579 and 3,159 years of light travel. Placed at the greater of these distances, I find that the sun would be reduced in brightness to a star of the 15th magnitude.

There seems to be evidence that the faint stars of the Milky Way have spectra of the Sirian type. Supposing, with Easton, that the fainter stars of the Milky Way are of the 12th magnitude, and, further, that they are comparable with Sirius in size and brightness, I find that their distance would be represented by about 4,600 years of light travel. But Sirius is, perhaps, a larger body than the average Galactic star. Its mass is about two and a half times the mass of the sun, and its brightness about 33 times greater. Possibly the stars of the Milky Way may be much smaller. Professor Kapteyn finds from an investigation of the probable distances and brightness of a number of stars of various magnitudes that in a volume of space containing two millions of stars of the same luminosity as the sun there would probably be about half a million brighter than the sun, and about $12\frac{1}{2}$ millions of smaller luminosity; that is, out of a total of 15 millions of stars, about $12\frac{1}{2}$ millions would be smaller than our sun.

To reduce the sun to the brightness of a star of the 12th magnitude it should be removed to a distance of about 790 "light years." To reduce the following stars to the 12th magnitude they should be removed to the distances represented by the light years given in the fifth column:—

STAR.	Magnitude.	Parallax.	Distance. Light Years.	Distance to which Star should be moved to reduce its light to 12th magnitude.
		"		Light years.
Sirius.. ..	−1 58	0 37	8·8	4600
α Centauri ..	0·06	0·75	4·31	1086
Capella ..	0 21	0·08	40·7	9300
Procyon ..	0·48	0 325	10	2030
α Aquilæ ..	0 89	0 231	14·1	2360
Aldebaran ..	1·06	0.107	30·4	4650
η Cassiopeiæ ..	3·64	0·154	21 1	1000
τ Ceti	3·65	0·31	10 5	500
70 Ophiuchi ..	4·07	0·16	20 3	794
o_2 Eridani ..	4·48	0·166	19	651
δ Equulii ..	4·61	0 071	46	1416
ε Indi	4·74	0·28	11 6	309
1830, Groombridge ..	6·47	0·15	21·7	278
Lalande, 21,185..	7·60	0·344	9·4	72
Kruger, 60 ..	9	0·271	12	48

Omitting the last two stars, which seem to be small bodies comparatively near the earth, we see that the distances of the others would range from 278 to 9,300 years, if all were reduced in light to a star of the 12th magnitude. The average of these is 2,921 light years. As these stars are of various sizes and brightness—their "relative brightness" compared with the sun ranging from 0.122 to 128.33*—we may, perhaps, assume that they represent nearly all classes of stars, and that the average distance of 12th magnitude stars is about 3,000 light years.

If we assume that the stars of the Milky Way are much smaller than Sirius, say one-half the mass of the sun, or one-fifth of the mass of Sirius, I find that the distance of 12th magnitude stars would be—if of the

* "KNOWLEDGE," July, 1903 † "KNOWLEDGE," August, 1901
‡ "KNOWLEDGE," August, 1895.

* See my paper on *The Relative Brightness of Stars* in Monthly Notices, R.A S, January, 1905

same density and surface luminosity as Sirius about 2,700 "light years." Let us assume with Newcomb that the outer boundary of the Milky Way is at about 3,000 light years, and see what average distance this will give between each pair of stars, on the supposition of an equal distribution of stars in a globular space. We know, of course, that the visible stars are *not equally distributed*, but the computation will give the average distance between any two adjacent stars. Assuming a total of 100 millions, and that each star is placed at the angle of a tetrahedron,* I find that the average distance between two stars would be about 21.24 light years. This corresponds to a parallax of 0″.153. Now I find that the average parallax of 20 stars, for which a fairly reliable parallax has been found is 0″.247. If we exclude those stars with a parallax of over 0″.3—which may, perhaps, be considered as exceptionally close to our system—we have 13 stars with an average parallax of 0″.155.

From a consideration of the proper motions of two groups of stars, one of 206 stars of mean magnitude 5.7, and mean proper motion of 0″.31 per annum, and another of 199 stars of mean magnitude 8.1, and mean proper motion of 0″.304, Mr. J. G. Porter finds "the average parallactic motion" of all the stars to be 0″.185; that is, the annual apparent motion due to the sun's motion in space. Taking this annual motion as four radii of the earth's orbit, that is, four times the sun's distance from the earth—a quantity probably near the truth—the mean parallax of the stars considered would be 0″.046, or about 70 years' journey for light. But judging from their magnitude these stars would not be among our nearest neighbours in space.

With a distance of 21.25 light years between two stars at a distance of 3,000 light years from the earth, I find that the apparent distance between such stars in the Milky Way would be about 24 minutes of arc, and as the faint stars in the Galaxy are, on an average, much closer than this, it seems highly probable that the stars composing the Milky Way are much nearer to each other than a distance of 21 light years, and this the crowded appearance of the Galaxy would lead us to suppose.

If we take the average width of the Milky Way as 20°, I find that the volume of space contained by lines drawn from the eye to the edges of the Galaxy is about 0.1767 of the volume of the whole sphere. Hence, with an equal distribution of stars, the Milky Way should contain about 17½ millions of stars. Now Dr. Roberts' photograph in Cygnus shows about 8,500 stars to the square degree. This would give a total of about 61 millions for the whole of the Milky Way. But as this is rather a rich part of the Galaxy the total may not exceed 40 or 50 millions; that is, two or three times that due to an equal distribution of stars. This agrees with some experiments made by Mr. Gavin J. Burns, who finds that the average luminosity of the Milky Way is from two to three times greater than that of the rest of the sky.†

Assuming that the Milky Way contains a total of 50 millions of stars, and that its limits lie between 1,500 and 3,000 "light years," I find that its volume would be about 0.1546 of the sphere having a radius of 3,000 light years. This would give an average distance between two adjacent stars of 14.36 light years. On this hypothesis the Milky Way would have a considerably greater extension in the line of sight than at right angles to that line. If we suppose that its thickness in the line of sight does not on the average exceed its apparent thickness; that is, that its cross section is roughly circular, and assuming that its mean distance is about 2,300 light years, I find that its diameter would be about 800 light years, its nearest and its farthest parts being at about 1,900 and 2,700 light years respectively. In this case the average distance between the component stars would be about 10.7 light years.

In the globular cluster ω Centauri, an enumeration made from photographs by Professor and Mrs. Bailly gives a total of 6,389 stars on an area of about 30 minutes square. This gives 25,556 stars to the square degree, and if the distance of ω Centauri is at all comparable with that of the Milky Way its component stars must be much closer than in any part of the Galaxy. The same may be said of the smaller Magellanic Cloud, which has about 28,000 stars to the square degree.

Easton thinks that the stellar universe is of "a fairly thick lens shape filled with stars which are much more closely congregated near the edges than near the centre of the lens." Professor Newcomb's views are somewhat similar. But this is returning to Sir William Herschel's "disc theory," and it seems doubtful whether such a conclusion is warranted by the evidence. As is well known, this disc theory was abandoned by Herschel himself in his later writings. I have never seen any answer to the argument against the disc theory advanced by me in "The Visible Universe" (pp. 241, 242). The argument is as follows:—As the thickness of Herschel's supposed disc extends on both sides of the earth beyond the theoretical distance of stars of the 9th magnitude, the stars of this magnitude should be as numerous in the direction of the Galactic poles as in the direction of the Milky Way itself. But this is not the case. Argelander's maps show that 9th magnitude stars are more numerous in the Milky Way than at the Northern Galactic pole in the ratio of 2½ to 1. Even the stars visible to the naked eye show a marked tendency to aggregation on the Milky Way, and Easton finds that the faintest stars of Argelander's catalogue—about 9½ magnitude—"present, by the manner in which they are distributed, a remarkable correspondence with the luminous and obscure spots of the Milky Way." These facts seem to be inconsistent with the disc theory as originally propounded by Herschel. From the evidence quoted above it seems evident that if the stellar system is in any way shaped like "a thick lens" there must be a considerable crowding of stars along the edge of the disc; that is, in the direction of the Milky Way.

Struve's modification of the "disc theory," namely, a disc of a certain thickness, but of infinite, or, at least, indeterminate, diameter, seems an improbable hypothesis, and one not in agreement with observed facts. Even on this theory our sidereal system is supposed to be limited in the direction of the Galactic poles. If Struve's theory were accepted we should also be obliged to accept his hypothesis of the extinction of light in the ether; for otherwise the Milky Way would be much brighter than it is. With an infinite extension, the Galaxy would shine with the brightness of the sun. The comparatively feeble gleam of the Milky Way on even the clearest nights should, I think, be sufficient to convince the thoughtful observer that its light is *not* due to a vastly extended stratum of stars. Even Sir John Herschel's reflecting telescope of 18¼ inches aperture (now far surpassed in space-penetrating power by modern instruments) sufficed in some places to show the component stars of the Milky Way on a *black* back-

* If *s* be the side of a tetrathedron, its volume is $\frac{s^3}{12}\sqrt{2}$.

† *Astrophysical Journal*, October, 1902.

ground devoid of any nebulous light. With reference to one of his "sweeps" he says, "The northern end of the zone, though pretty rich in *stars*, is yet quite free from brightness of ground. It is as black as a coal," clearly showing that his optical power could—here, at least—fairly penetrate through the stellar stratum into the starless void beyond.

Photographs of some portions of the Milky Way show the fainter stars as points of light on a black ground devoid of all nebulosity. More powerful telescopes and more sensitive plates will probably disclose the existence of many fainter stars, but all the evidence we have at present seems to point to the conclusion that the utmost limit of telescopic vision will soon be reached, and that the most powerful telescope which man can construct will ultimately show that the stars, even in the richest portions of the Milky Way, are strictly limited in number.

The general aspect of the Milky Way seems sufficient to negative the "disc theory." The numerous convolutions, rifts, and "coal sacks" shown in the drawings of Boeddicker and Gould and in photographs of the Milky Way can hardly be explained by the honeycombed structure of a stellar disc, and one finds it difficult to resist the conclusion that the apparent streams of nebulous light which are seen branching out in many directions from the Galactic zone are really streams of stars and nebulous matter in space, and that the apparent openings or holes, known as "coal sacks," are, in reality, perforations through a stellar stratum of comparative thinness rather than cosmical tunnels of immense length pointing directly towards the earth.

With reference to the clusters and nebulæ, the distance of these objects has not been ascertained; but from the fact that stars, clusters, and nebulæ are mixed up in the Magellanic Clouds in a space which is apparently of a nearly globular form, we may conclude that all these diverse objects may co-exist in the same region of space, and that, consequently, the nebulæ are not, as a rule, farther from the earth than the faint stars seen in the same direction. Photographs of the Magellanic Clouds, taken by the Harvard observers, show that these objects are very rich in small stars. Photographs of the large cloud show about 300,000 stars. This would give about 300 millions for the whole sky, if equally rich. The small cloud seems still richer, as the photographs show about 280,000 stars on an area of about 10 degrees. This would give the enormous total of 1,155 millions for the whole sky, and it is, perhaps, the richest spot in the heavens. Assuming a distance of 3,000 light years, I find an average distance between the component stars of the large cloud of about 9½ years, or more than the distance between Sirius and the earth; and for the small cloud an average distance of about 5 years. It will be seen that both are considerably less than the average for the whole sky, and show that the stars in the clouds are crowded together.

Seeliger estimates that the limits of the Milky Way lie between 500 and 1,100 times the distance of Sirius; that is (the distance of Sirius being 8.8 light years), between 4,400 and 9,680 light years. At these distances the sun would be reduced to the magnitudes 15·7 and 17·4 respectively. As most of the stars in the Milky Way are much brighter than this, and as most of them are, according to Kapteyn, smaller than the sun, we may, I think, reasonably reject Seeliger's distances as excessive. Newcomb's distances are probably much nearer the truth.

Miniature Harmonographs.

By CHARLES E. BENHAM

ONE of the chief drawbacks of the harmonograph is its cumbersome character and the heavy weights required. By adopting the method described in the January number of "KNOWLEDGE," of making the recorder a needle point attached to a light strip of paper, friction is so far diminished that it is possible to reduce the size of the apparatus, and to make use of weights of not more than 1lb. each. It might be supposed at first sight that the avoidance of friction which this device secures could be attained just as well by counter-balancing the pen lever, but this is not so, for the counter-balanced

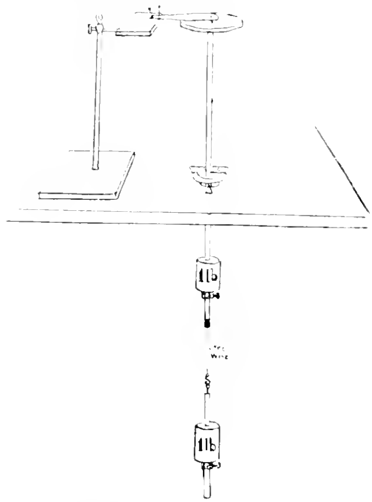


Fig. 1.—Miniature Twin-Elliptic Pendulum.

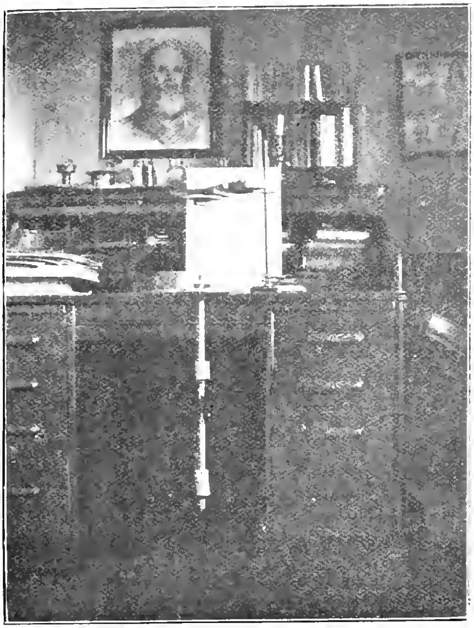
lever if brought so near to equilibrium will bounce, and prove quite unsuitable for carrying the pen that is to record a continuous line.

Fig. 1 shows a miniature twin elliptic pendulum of very simple construction. A pendulum rod, ½ inch thick, and 20 inches long, is mounted on gimbals at the centre, and passes vertically through a hole of about 2 inches diameter in a firm table. The gimbals are formed by a flat light steel ring, resting on knife edges rising from the table and receiving on its upper surface the knife edges of the pendulum, at right angles to those under the ring. At the top of the pendulum is a flat round table, about 4 inches in diameter. The pendulum weight (1 lb.) slides up and down the lower part of the rod and can be fixed by the perforated nut and screw below it.

The rod terminates in a metal cap in which is centrally fixed, embedded in lead, a hanging thin steel wire (a "first" mandoline string). The other end of the steel wire terminates in a loop to which by means of a brass

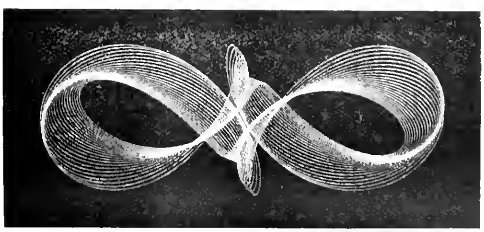
S-shaped hook, a second pendulum rod, about 8 inches long, is attached, this rod also carrying an adjustable weight of 1 lb.

The weights can be cast in the cylindrical boxes used for incandescent gas mantles, the central hole being



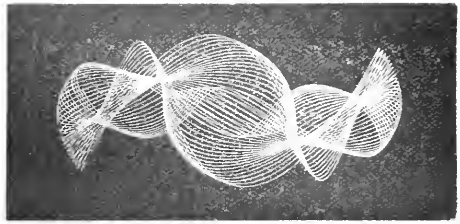
The Miniature Twin Elliptic Pendulum.

provided for by an upright rod fixed vertically in the mould, which must be quite dry when the melted lead is poured in, or there is danger of the hot metal flying out. A half-inch wooden rod, with a few folds of paper round it, will give a central hole of the right size.



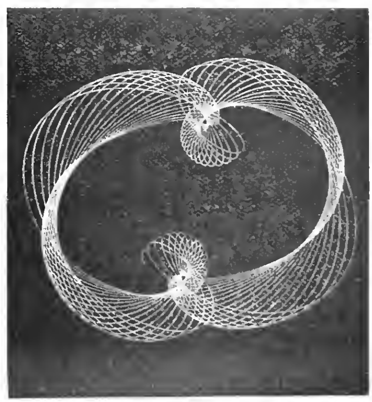
Approximate 1 : 3 harmony (opposed rotation) traced with miniature twin-elliptic pendulum.

The needle to trace the curves should be as fine as possible and about [illegible] inch long. The fragment is stuck vertically through a strip of writing paper [illegible] inches by 1 inch, tapered a little at the end which holds the needle point. A drop of glue holds the needle firmly in position. The other end of the strip is fastened by [illegible] pins to a small flat board, supported on a retort stand or other convenient support, so that it can be raised or lowered to the required level. Smoked paper is placed on the pendulum table-top, and when the apparatus is started, the strip, which had been supported by a knitting needle held in the left hand, is allowed to drop upon the smoked surface, where the needle traces the curve described.



Approximate 1 : 3 harmony (opposed rotation) traced with miniature twin-elliptic pendulum.

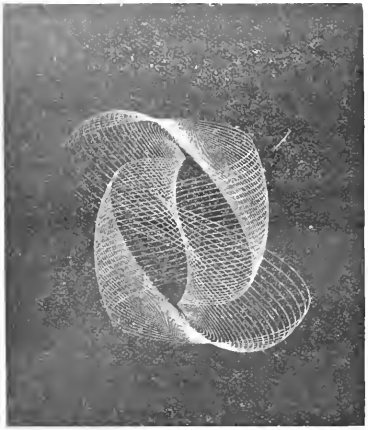
Enamelled paper, such as is used for "process" illustrations, must be used, and it should be fixed in a little frame, such as a child's drawing slate, the surface being then evenly smoked with the flame of a wax taper, holding the lighted taper horizontally under the paper and moving it to and fro until the whole surface is evenly covered. The frame with the paper still fixed in it is laid on the table top. It requires no clip to hold it, the friction not being sufficient to move it.



Approximate 1 : 3 harmony (concurrent rotation) traced with miniature twin-elliptic pendulum.

To fix the tracings, take the paper from the frame, and brush the back of it with a fixative made of hard white varnish one part and methylated spirit four parts. When dry the smoked surface is fixed and may be improved by polishing it lightly with a clean tuft of cotton wool.

The best figure is the approximate 1 : 3 harmony, of which examples are reproduced. This figure in its different phases gives hundreds of variations. No figure is symmetrical, even though harmonic, unless the difference between the two numbers composing the ratio is an even number, such as 1 : 5, 3 : 7, or 3 : 5. On the other hand 1 : 2, 1 : 4, 2 : 3, and any ratio where the difference is an uneven number, give harmonies which are non-symmetrical.



Approximate 1 : 3 harmony (opposed rotation) traced with miniature twin-elliptic pendulum.

To start the instrument hold the rod near the top and give it a slight circular movement followed by a very slight reverse impulse. This will start the two pendulums in opposed rotation. A single impulse will start them in concurrent rotation.

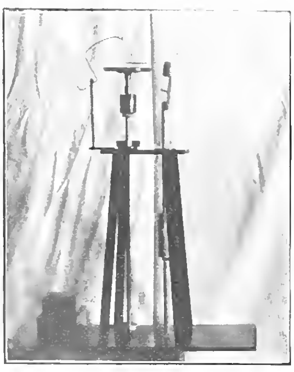


Fig. 2.—Miniature Harmonograph (Tisley type). The paper strip with needle is attached to the pendulum on the right and is supported by a silk thread hanging from the wire on the left, which lowers the needle for describing the curves, the silk then hanging loose. As shown, the weights are adjusted for the harmony 1 : 3.

To tune the instrument, adjust the upper pendulum weight to various positions until an approximate harmony is reached. If the repeat line falls in advance, raise the upper weight a little ; if it lags behind lower the upper weight. The weight on the lower pendulum may be raised and lowered with similar effects, but in a less marked degree, so that it is only necessary to alter it for fine adjustment.

The ratios of the harmonies obtained are thus computed: With concurrent movement the nodes (*i.e.*, loops or points) are inside the figure and their number is the difference of the numbers in the ratio. With opposed movement the loops are outside, and their number is the sum of the numbers in the ratio. For example, if with concurrent rotation there are eight internal nodes, while with opposed rotation there are 14 external loops, $x+y=14$; $x-y=8$. $8+2y=14$, $y=3$, $x=11$, or the ratio is 3 : 11.

Fig. 2 shows an ordinary harmonograph of miniature form, which by means of the paper strip device gives very fine tracings, though the weights are no heavier than those in the miniature twin elliptic. By using a top-weight harmonies of 1 : 3 can be obtained with this little instrument. Two specimens of its work are reproduced.

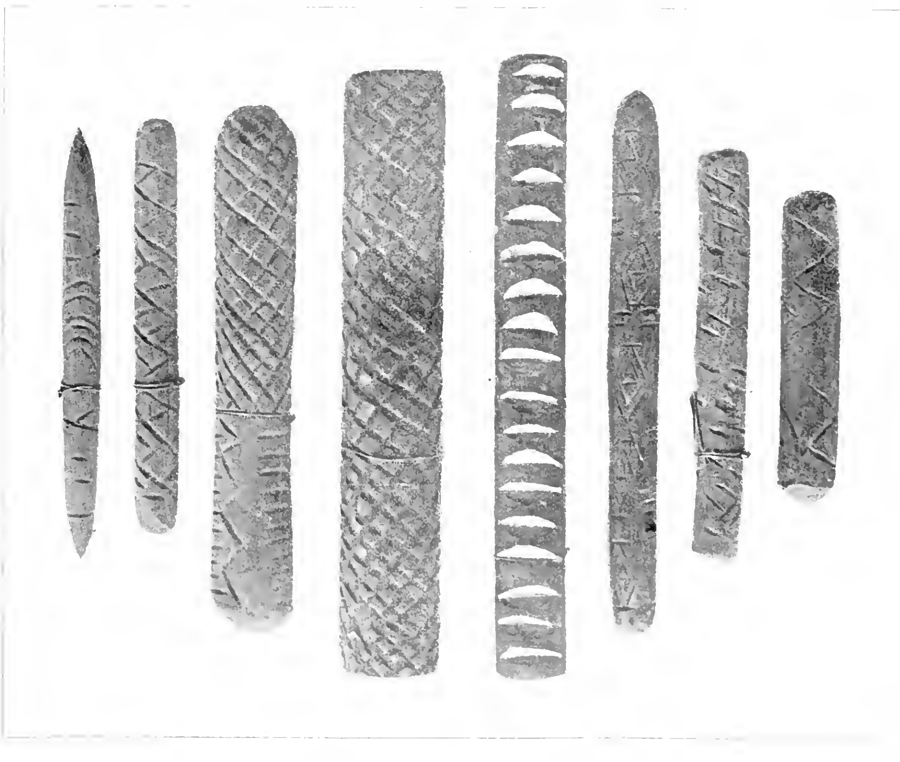
A similar recorder would probably be very serviceable for seismographs, and for any purpose which involves the registering of minute oscillations.

Queensland Message Sticks.

A GOOD deal of uncertainty and a large amount of speculation surround the methods by which the members of aboriginal races communicate one with another. Numerous legends have collected about the so-called message-sticks of the Queensland natives, which have been said to serve the purpose of conveying messages from one part of the colony to another among the natives. Some authentic explanation on the point is supplied by Mr. Walter Roth in Bulletin No. 8—North Queensland Ethnography, which is published by the Queensland Government. Mr. Roth writes :—

"The limited quantity and portability of a native's personal goods offer little or no opportunity for the use of property-marks. If weapons are of the same cut, there are minute, yet sufficient, differences which are recognisable to the owners ; even if similarly ornamented, no two are so alike that they cannot be distinguished. In a general way, each having sufficient for his own wants, and no person having more than another, there is nothing to thieve, and hence, as already mentioned, the levity with which theft, even when it occurs, is regarded. Only in cases of trade and barter, through an intermediary, where it is essential that one individual's goods should be distinguished from another's, is there a necessity for a definite property-mark, this taking the form of a so-called 'letter-' or 'message-stick.' Under such circumstances, the 'stick' may be put into use as follows :—Charlie, residing at Boulia, wants, we will say, some pituri, but being prevented by sickness or some other cause from going himself, sends some relative or friend Peter to the nearest market, on the Mulligan River, to get some for him, and gives him a 'message-stick.' Arrived at last at his destination, Peter is asked his business, tells who has sent him, hands over the 'stick,' and establishes his *bonâ fides*. The bagful of pituri being at last forthcoming, the vendor returns the 'stick' to Peter, but not before taking careful mental note of it, so as to be sure of recognising it again. Peter returns at last to Charlie at Boulia, and delivers up both pituri and stick. It now remains for Charlie to pay for the pituri with spears, boomerangs, &c. If he can prevail on Peter to take a second trip, all well and good, but if not, as is usually the case with so long a journey, he either proceeds himself or sends another messenger with the goods and the identical 'message-stick' as before. He, or the second messenger, arriving at the Mulligan, finds the vendor, and gives him the spears, boomerangs, &c., together with the 'stick.' Recognising the latter, the seller accepts the various articles in payment for the bagful of pituri which he parted with some few weeks previously, knowing now that he has been paid by the right person, probably personally unknown to him—*i.e.*, the sender of the original 'stick.'

"I am absolutely convinced that the marks on the so-called letter- or message-sticks do not convey the slightest intimation of any communication, in the ordinarily accepted sense of the term, from sender to receiver; this view is based mainly on the grounds that the same message may accompany different sticks, the same stick may accompany different messages, and the stick may bear no marks at all. I have been given a stick to take with a certain message to another district, and purposely mislaid it temporarily, in order to secure another specimen. Again, 'second hand' sticks may be used over and over again by strangers, who certainly have had no knowledge of the original manufacturers. Sometimes a broken twig is sufficient, without any incisions whatever, and I have often seen a piece of tea-tree bark, or even a rag, just tied round and round with twine, to constitute the so-called letter. To put the matter plainly, the message is taken verbally, the stick serving only to accentuate the *bonâ fides* of the messenger; if the messenger is known to both parties, no stick is sent. On the other hand, there is a more or less uniformity recognisable in the shape of the sticks manufactured in different areas; the flat feather-shape of the Boulia district bears a strong contrast to the squared form of the letters met further North. Occasionally, the stick may be affixed with twine to a handle, carried vertically in front, and the suggestion has been offered that this expedient is resorted to when the messenger is travelling through hostile country, so as to give him immunity for trespassing; my experience is that, under such circumstances, he would avoid any risk of being seen by travelling only at night. I have often seen a civilised black boy, on the road, holding in front of him a short twig, in the split extremity of which an envelope, &c., has been inserted; at a distance it resembles a flag somewhat."



We reproduce one of Mr. Roth's photographs of message-sticks. There are many other forms, but these appear to be as characteristic as any.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Specially Sensitised Plates.—A little more than a year ago I referred to the advantages of bathing plates in the prepared dye solution in order to increase their sensitiveness to green, yellow, and red, as compared with the incorporation of the sensitising substance with the emulsion before the plates are coated, and stated that Messrs. Sanger-Shepherd and Co. were preparing to issue a bathed plate commercially. The difficulty, if not the impossibility, of preparing bathed plates in large quantities that shall be uniform in the various batches and remain without appreciable change for a sufficient time to render them practically available for general work, has caused this firm to issue an emulsion sensitised plate instead. The "Sanger-Shepherd" plate is of excellent quality, moderately rapid, and shows a very even sensitiveness to red, green, and yellow, when tested by daylight. In this it is much superior to many plates specially sensitised for red or for the three colours named. The proportion of red sensitiveness to total sensitiveness in the sample I have examined is somewhere about four times as great as in the plates that Messrs. Sanger-Shepherd and Co. used to supply for use in their process of colour photography, and this indicates a very great improvement.

Plates bathed with pinachrome and with pinacyanol have recently been put on the market by Messrs. Wratten and Wainwright, and the makers state that they are of very great general sensitiveness, and that the sensitiveness of one of them at least to yellow light is almost equal to its sensitiveness to blue light. I have not seen a statement as to the sensitiveness to red of either, though they are claimed to be specially good in this matter, and presumably with very good reason.

For those who desire bathed plates without the trouble of treating them, Messrs. Penrose and Co. announce that they are prepared to sensitise plates by bathing to order, using either of the following dyes:—orthochrome T for general colour sensitiveness, pinachrome for general sensitiveness with a high speed, pinacyanol for red sensitiveness and high speed, dicyanine for sensitiveness to red extending to the less refrangible colour, and also, for green sensitiveness, tetrabromfluorescein, diiodofluorescein, homocol, and ethyl red. The plates will keep in good condition for two or three weeks. This will doubtless be a great convenience to many workers, and they will have the advantage of knowing exactly what sensitiser has been employed. On the other hand there are advantages sometimes in the use of mixed sensitisers as exemplified in commercial plates, and the experimental work that guides manufacturers is not generally available.

The Choice of Sensitisers for Red Light.—There have lately been introduced several sensitisers for red in addition to the two or three that have been known for many years. Mr. W. A. Scoble has recently communicated to the Royal Photographic Society the results of his comparative experiments with all that are practically available, nine dyes in all. For getting sensitiveness to the extreme red pinacyanol is effective as far as A, dicyanine nearly as far, while alizarine blue S sensitises into the infra red, but has the disadvantage of being, as others have found it, uncertain. In consequence of this difficulty he has selected pinacyanol as the best for his work, though his observations on the colour changes of alizarine blue S when in solution seem to go far towards eliminating the uncertainty of its effects.* A noteworthy statement in his communication is that he found no appreciable difference whether he exposed the plates wet soon after being bathed, or after being dried. The use of the undried plates saves not only the time and trouble of drying, but the risk of deterioration, which is considerable with some sensitisers.

Will Specially Coloured Sensitised Plates be much appreciated?—It cannot but occur to those who take an interest in the matter to ask themselves whether the facilities referred to in the two previous sections will meet with due appreciation. If I had to answer this question I should reply in the negative. Plates sensitised for green have been on the market for about twenty years, their advantages have been incessantly proclaimed, but even to-day they are very rarely properly used, and it is often necessary to draw attention to their existence. I should not be surprised if ten years hence red sensitised plates will still stand in need of special pleading so far as general photography is concerned. It is the needs of the trade in the practise of three-colour work that has been the chief incentive in the investigations connected with red sensitisers. The vast majority of photographers probably do not know that when they photograph a dark slated roof with a ridge of light red tiles on it, the tiles come out darker than the slates even when an "orthochromatic" plate is used with a screen. The want of discrimination on the part of photographers and those who look at their productions is the cause of the absence of a demand for correct representations, and no demand, of course, means no supply. Improvements in red sensitiveness will be quickly utilised by spectroscopists because in their work nothing can take its place; in microscopy and certain other scientific work they will slowly find appreciation; but for general purposes I fear that they will remain neglected except by an enthusiastic few. It must be admitted that it needs enthusiasm to make the sacrifices that must be made if the possibilities of such plates are to be fully taken advantage of. And certainly there is a great deal to be said in favour of the facilities that at present are incompatible with red sensitiveness.

Dark Rooms.—Photographers when working away from home, whether in the British Isles, on the Continent, or even in the more remote parts of the world, will find "A Directory of Public Dark Rooms," published by Messrs. Dawbarn and Ward at 3d., of much use. It contains nearly three thousand entries. But if anyone should happen to go on tour without such information, he should look in likely places for a bold dark blue Maltese cross six inches square on a rather larger card or enamelled iron sheet. Wherever this sign is displayed there is a dark room available, and also a copy of the directory of dark rooms that may be consulted by visitors. This arrangement is fairly well established, for it has been in force some four or five years, and in order to perfect it, the publishers would be grateful to receive any intimations of errors or omissions that are noticed in the directory.

Notice.—The Royal Photographic Society has arranged an exhibition of works by the members of the Birmingham Photographic Society, at 66, Russell Square, which will remain open to the public daily till the 16th inst.

* Since writing this Mr. Scoble has personally assured me that by observing the precautions as to colour changes given in his paper, he finds that the uncertainties hitherto found in the use of alizarine blue are entirely eliminated

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Determination of Stellar Radial Velocities with the Prismatic Camera.

MANY attempts have been made during the last few years to utilise the large light-grasping power of the objective prism for determinations of stellar radial velocities. The chief difficulty is in consequence of there being no known method of introducing a comparison spectrum to give the constants from which to measure the displacements. A method has recently been described by G. C. Comstock, in which he proposes to employ a specially constructed double prism, which is fixed with the refracting angles inverted so as to give two overlapping and crossed spectra. By measuring the distance apart of known spectrum lines in the two spectra produced of each of the stars whose velocities are required, and subsequently comparing these measures with the distance between similar lines on a standard star, a determination of the velocity in the line of sight can be obtained. *Astrophysical Journal*, March, 1906.

Results of the American Eclipse Expedition, August 30th, 1905.

The expedition was divided into three parties, the members of which occupied stations at Daroca and Porta Coeli, in Spain, and at Guelma, in Algeria. Preparations were made for photographing the corona with long and short focus cameras, and for spectroscopic photography of the sun's chromosphere and corona. Thirty-six pictures of the corona were obtained at the three stations. Several excellent spectra were photographed with the four-inch parabolic diffraction grating, ruled with 14438 lines to the inch, and having a focal length of five feet. The flash spectrum extends from D_3 in the yellow, to λ 3300, and shows a great number of lines. With the six-inch grating, the spectrum of the green coronal ring at λ 5303 shows most interesting details, at least 15 or 20 small streamers being visible for some distance beyond the moon's limb. A special feature of this corona spectrum is the presence of a *dark streamer*, almost radial, and bordered by bright streamers on either side, which was projected from the moon's limb at latitude 55° or 60°, on the sun's east limb. This peculiar feature is also well shown on the 15-foot camera pictures of the corona.

The Fraunhofer dark crescents, as seen visually with the spectroscope, became visible about seven minutes before the second contact, while D_3 and the hydrogen lines became brightly reversed at about one-and-a-half or two minutes before. It was particularly noticed that the green magnesium lines persisted until near mid-totality.

Polariscopic observations were only made at the Guelma station, with very satisfactory results. Inside of 5′ of arc there is practically no radially polarised light, showing that the luminous matter is, in all probability, solid or liquid, as is further evidenced by the continuous spectrum of this region. Between 5′ and 10′ of arc, the amount of polarised radiation increases very rapidly, indicating that this light is chiefly reflected sunlight. *Astrophysical Journal*, March, 1906.

Parallax of the Nebulae.

The distances of the nebulae are at present practically unknown, as on the whole they are exceedingly difficult to measure exactly, and, in consequence, direct observations of their parallax are not very consistent. In the hope that an investigation of their proper motions might give better results, J. C. Kapteyn has recently examined the extensive series of nebulae made by Monnichmeyer, at Bonn. For convenience and accuracy of calculation, the whole term of the proper motion is not used, but only that component of it directed *towards the antapex*. The analytical method of reduction adopted assumes that the sum of the projections on some determined direction of the *peculiar* proper motion vanishes in the case of very numerous nebulae; of the 208 nebulae available for the discussion, 168 were finally selected, and the mean deduced parallax of these is 0.0046″ ± 0.0012″. It is important to note that this value is very nearly equal to that found for the mean parallax of stars of the tenth magnitude, and as this result is from the discussion of only thirty years' observations, it is suggested that much better determinations might possibly result from a photographic investigation, which would render possible the measurement and reduction of the places of a much greater number of nebulae.

Variation of Absorption Bands of Crystals in Magnetic Field.

All determinations of the circumstances causing modifications of spectrum lines of substances, either as to intensity or position, become of great importance in astronomical spectroscopy when applied to the examination of stellar spectra, where many peculiar features are found which have not, as yet, been produced terrestrially. Professor Becquerel has recently given an account of several researches, in which he subjected the absorption spectrum of various crystals to very strong magnetic fields, and he finds very interesting changes thereby introduced. The crystal showing the effect most clearly was Zenotine (a phosphate of ytria, with erbium and rare earths). This is a uniaxial crystal, which exhibits very fine absorption bands, which were spectroscopically examined with a Rowland grating, a nicol prism being introduced to separate the polarised components. The wave lengths of the lines observed were determined from a comparison spectrum of iron. The effect of the field (which was used up to 31,800 C.G.S.) is much larger than the corresponding action on metallic vapour spectra, and is found to vary with the orientation of the crystal, and the direction and strength of the field.

Important instances of dissymmetry are mentioned, which appear to be independent of the direction of the magnetic field. Another remarkable feature is the variability of *sense* in which the magnetic field displaces circular vibrations, whose sense is originally the same. This appears to be a selective action, which, Professor Becquerel suggests, may be due to certain bands corresponding to the vibrations of *positive electrons*, which, if proved, will add considerably to our knowledge of the inner constitution of matter. *Comptes Rendus*, 13-15 (1906).

New Radcliffe Catalogue of Stars for Epoch 1900.

The new catalogue recently issued from the Radcliffe Observatory, Oxford, contains the results of observations made with the transit circle between the years 1894 and 1903, both inclusive, under the direction of A. A. Rambaut. Owing to various causes beyond control, the observations were interrupted several times, but this has not been allowed to influence the precision of the results, which are shown to be of a high order of accuracy. The present catalogue gives the position of every star down to the seventh magnitude contained in the zone 85°—90° N.P.D., with very few exceptions, and those only in the case of double or multiple systems.

Very elaborate determinations of the pivot errors were made by a modification of Hamy's method, in which interference fringes were produced between two plates, one of which suffered displacement when various parts of the pivot were being examined.

Full analytical details are given of the reductions, and comparisons with other standard catalogues.

Shadow Bands at Sunrise and Sunset.

Another series of interesting observations, which appear to throw light on the curious shadow band phenomena during total solar eclipses, have been recently described by Monsieur C. Rozet. In December, 1905, M. Amann saw distinct bars of light and shade on the surface of a partition, at the instant of the sun's appearance above a mountain. This led M. Rozet to make arrangements for obtaining a more definite determination, and he fitted up a white screen inside a room facing the point of sunrise. The bands were easily seen, and were generally straight, parallel, and not at all likely to be confounded with the irregular shadows produced by convection currents near the screen. As the result of 75 observations, he makes the following conclusions:

(*a*) The orientation of the dark bands, on a screen of perpendicular rays, is constantly parallel to the part of the mountain edge over which the sun is rising or setting.

(*b*) The direction of their displacement is always perpendicular to their orientation, but may be in one of two directions—direct or retrograde.

(*c*) The velocity of the motion of the bands varies considerably from time to time, which may have some relation to the force of the wind, as the most rapid movements occur during high winds, and the slow ones during calm weather.

(*d*) The bands cease to be visible two or three seconds before the sun sets, and may become visible several seconds after sunrise. If the disappearance of the sun takes place behind a vertical screen, the time of apparition may be lengthened to 12-15 seconds.

(*e*) At first the bands are wide and far apart, becoming sharper and straighter later. Their width usually was 3-4 cm., and distance apart 3-4 cm., but might vary from 1-20 cm. The width and distance apart appeared to vary with the velocity of translation.

(*f*) The colour of the bands was generally of a uniform grey.

The distances of the mountains over which the phenomena have been observed, have varied from 6-36 km., with elevations of 3°-22°. In spite of these variations, the features of the bands have been fairly constant.—*Comptes Rendus*, 15, 1906.

Vesuvian Origin of Paris Fog, April 11th, 1906.

In corroboration of the evidence furnished by the many striking sunsets during the latter part of April, there may be considered the finding of volcanic dust in Paris just after the eruption. M. S. Meunier describes how, during the dry, yellow fog which enveloped Paris on the 11th of April last, he exposed gelatinised plates near the Quay Voltaire, and after treating these with water, he obtained a deposit from which the soot and organic matter were removed by Thoulet's heavy liquid. There remained an extremely fine residue, the microscopic examination of which showed almost perfect identity with a sample of the dust emitted from Vesuvius in 1822. The chief difference consisted in the presence with the Paris dust, of small, perfectly spherical globules of oxide of iron. It thus appears most probable that the Paris fog was produced by a fine rain of cinders which had been carried from the Vesuvian area.

Photography of Corona without Eclipses.

MM. Millochau and Stephanik propose to start a new attack on the problem of photographing the solar corona during daylight, by combining the use of the spectroheliograph and coloured screens. As the corona is projected on a background of extremely bright sky, it is hoped that the relative intensity of the corona will be enhanced if a screen is interposed which cuts off all light except that of a green colour in the region of wavelength 5303. Then, by setting the secondary slit of their spectroheliograph on this line, the increased contrast produced may render possible the record of the coronal form. Preliminary attempts at Meudon are said to have given encouraging results, and the apparatus is to be transferred to the Observatory on the summit of Mont Blanc, where the absence of the lower and denser layers of the earth's atmosphere may further conduce to success.

BOTANICAL.

By G. Massee.

Sexuality in the Mucorineae

It has long been known that a sexual mode of reproduction existed in the group of fungi known as the Mucorineæ, of which the moulds common on bread and various fatty matters are well-known examples. The result of sexual fertilisation consists of a structure called zygospore, which, after a period of rest, germinates, and at once gives origin to a mucor-plant. A second form of reproduction produced asexually is much more general than the sexual condition, and appears under the form of myriads of miniature pins, with golden heads, which eventually become black.

The subject of sexuality has recently been prosecuted from a new standpoint, by Blakeslee. It was observed that some species could be readily induced to form zygospores, by sowing spores obtained from a single fruit of the asexual form. On the other hand, in many species, zygospores were never produced from spores contained in a single asexual fruit, but only when a mass of spores from a zygosporic culture was used. When isolated cultures of the last-named group were grown in proximity on a suitable medium, it was observed that zygospores were formed along the line where the mycelium of the two colonies met. This suggested the idea that such species consisted of strains, or races, which, when grown apart, produced only a sexual fruit or sporangia, but which produce sexual fruit, or zygospores, when the two physiologically different strains are grown in contact. These are designated respectively + and (−) strains, which is considered as non-committal as to the sexual relation of the respective strains.

This condition of things is essentially similar to that present in dioecious plants and animals, although morphological differentiation is not obvious in the Mucorineæ.

The term heterothallic is used to designate those forms that are dioecious, and homothallic is applied to the hermaphrodite species. Hybrids have been produced from (+) and (−) strains of different species of the heterothallic type.

The following is a part of the author's summary of this important discovery:

"The production of zygospores in the Mucorineæ is conditioned primarily by the inherent nature of the individual species, and only secondarily by external factors.

"According to their method of zygospore formation, the Mucorineæ may be divided into two main groups, which have been termed respectively homothallic and heterothallic.

"In the homothallic group, comprising the minority of species, zygospores are developed from branches of the same thallus or mycelium, and can be obtained from the sowing of a single spore.

"In the heterothallic group, comprising probably a large majority of the species, zygospores are developed from branches which necessarily belong to thalli or mycelia, diverse in character, and can never be obtained from the sowing of a single spore. Every heterothallic species is, therefore, an aggregate of two distinct strains, through the interaction of which zygospore production is brought about.

"These sexual strains in an individual species show in general a more or less differentiation in vegetative luxuriance, and the more or less luxuriant may be appropriately designated by the use of (+) and (−) signs respectively.

"A process of imperfect hybridisation will occur between unlike strains of different heterothallic species in the same, or even in different genera.

"From the foregoing, it may be concluded that the formation of zygospores is a sexual process; that the mycelium of homothallic species is bisexual; while the mycelium of heterothallic species is unisexual; and finally, that the (+) and (−) strains of the heterothallic group represent the two sexes."

The zygospores require a period of rest before they are capable of germination.

Marine Fungi.

H. E. Petersen has studied the microscopic fungi belonging to the Chytridineæ, parasitic on marine algae. Twenty-five species were collected on the Danish coast, and further north, and are described in detail in *Overs. k. Danske. Vidensk. Selsk. Folk.*

New British Algae.

Notwithstanding the work of centuries in investigating the flora of Britain, additional new, or previously unrecorded, species continue to be found. Batters, in *Journal* *of Botany*, has some interesting notes on eleven new or critical species of British marine algae. Two of these were previously unknown, and three more belong to genera not previously recorded as British. Most of the species are minute, of the two new species, one, *Diplocolon Codii*, grows between the cortical cells of another alga, *Codium tomentosum*. The other new species is named *Mesogloia neglecta*, which has probably been previously passed over as *Mesogloia Griffithsiana*, which it superficially much resembles, but is distinguished by the much shorter cortical filaments and larger spores.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Action of Radium on Precious Stones.

EXPERIMENTS made by Herr Miethe have shown that many precious stones are changed in colour when exposed for some time to the action of radium rays. Thus a colourless diamond from Borneo became pale yellow after eight days' exposure to the rays of an impure radium bromide, and the colour became much darker after another eight days. Heating the stone to redness reduced but did not destroy the yellow coloration. In the case of a sapphire, the light blue colour changed to green after two hours' exposure to the rays, then yellow, reddish yellow, and, finally, after 14 days, yellowish-brown. The colour disappeared on heating the sapphire, but a light yellow tint invariably re-appeared when the stone became cold. The rays did not affect the colour of the amethyst, ruby, blue topaz, or chrysoberyl; but a tourmaline with a green end became green at any other part on which the rays were allowed to act.

Philippine Wood Oils.

Fluid resins closely resembling balsams in composition and characteristics are in common use as varnishes throughout the Philippine Islands, and the best known of these have recently been examined by Mr. A. M. Clover. *Oil of supa* is obtained from *Sindora Wallichii*, a tree widely distributed throughout the Islands. The oil, of which about ten litres are collected from each tree, is a mobile pale yellow liquid, which rapidly becomes dark and viscous on contact with the air, and slowly dries to a hard film when spread in a thin layer. In certain districts it is also used as a lamp oil. A similar product known as balao, or *oil of apitong*, is collected by cutting cup-shaped cavities in the apitong tree. It is white when fresh, but rapidly darkens on exposure to the air, and spread in thin films forms a very tough varnish. It is superior to supa oil in its drying properties, and also differs from it in becoming solid on contact with steam. Malapaho, or *oil of panao* is a colourless product, obtained from the tree *Dipterocarpus vernicifluus* by the same method. It dries but slowly on exposure to the air, and is thus not used to the same extent as balao or supa oil. It also differs from the former in becoming more mobile under the influence of steam. Chemically, all these wood oils consist almost entirely of the hydrocarbons known as sesquiterpenes. They are more or less volatile in a current of steam, and are quite distinct from the ordinary drying vegetable fixed oils, such as linseed or walnut oils, which consist of compounds of glycerin with different fatty acids.

Trachinus Venom.

It had long been suspected that the poison glands of the greater weever (*Trachinus draco*) contained a definite toxine, but it was not until 1903 that this was shown by M. Briot to be the case. He obtained poisonous solutions possessing the characteristic properties of true toxines by extracting the gland with glycerin containing chloroform, but did not isolate the poison in anything approaching a state of purity. The work that has been done on the subject is reviewed by Dr. Oppenheimer in "Toxine und Antitoxine," an English edition of which is now announced. The toxine has a direct action upon the heart and causes convulsions and paralysis, the latter being a characteristic symptom. It is destroyed by being heated for 30 minutes at 212° F. and by calcium chloride and gold chloride. In addition to its toxic function trachinus venom resembles snake venom in having a hæmolytic function, *i.e.*, the power of dissolving the red corpuscles of the blood. This lysine in the venom is destroyed when heated for about 20 minutes at 212° F., and is thus less stable than the toxic principal. The normal serum of the horse contains an anti-hæmolysine against trachinus lysine, just as it does against the hæmolysine of snake venoms. Trachinus venom, however, is quite distinct from snake venom, for it acts in quite a different manner, and a serum rendered antitoxic to snake venom has no effect upon either the toxic or hæmolytic function of trachinus venom. It is possible to produce a certain degree of immunity to the venom in rabbits by cautious injection of a diluted venom, and the serum of the treated animal then contains a specific antitoxine, which, however, does not invariably afford protection against the local effects of the poison. The venom of *Trachinus vipera* is very similar to that of *T. draco*, as regards its effect upon guinea pigs, but has much less action upon rabbits. Several other fish, *e.g.*, the lamprey, appear to contain poisons which act as definite toxines, but these have not yet been investigated. The venom of the poisonous Japanese *Tetrodon* (*fugu*) and of certain other fish, appear to contain poisonous compounds of the nature of substituted ammonias rather than true toxines, *i.e.*, unstable specific poisons capable of producing specific antitoxines in the serum of an animal.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Great Californian Earthquake.

THE stoppage of the fires of Vesuvius has been signalised by a great earthquake which has laid San Francisco in ruins, and has resulted in a devastation such as has been unknown in any civilised territory during the present generation of mankind. Was there any connection between the one and the other, is a question which will at once be asked. The greatest caution must be exercised before giving an answer. If merely a coincidence, it is a remarkable one. It is certain that an enormous vacuity must have been formed in the place which fed the eruption from Vesuvius. Other material must have flowed in from regions around, and stupendous underground movements of the kind would have equivalent results. The result might be a caving-in, through lack of support, of some spot of weakness in the earth's crust, and the formation of one or more great faults. The shock or shocks which would be given rise to would travel in every direction, and when they reached the surface of the earth the effect would be disastrous. Possibly secondary shocks would follow later from refraction or reflection from the earth's central core. To some such causes the present earthquake is attributable, and in this connection it is well to remember that the great Charlestown earthquake followed the closing of the great crater of Kilauea, in the Sandwich Islands.

Some Details of the Recent Eruption.

While the recent Vesuvian outburst was fresh in the public mind, Professor Guiseppe de Lorenzo contributed a paper to the proceedings of the Geological Society, which he wrote while yet the decrescent phase of the eruption was being pursued. The maximum outburst took place during the night of April 7-8, and blew 3,000 feet into the air, scoriæ and lapilli of lava, with fragments derived from the wreckage of the cone. A south-westerly wind swept the ash, it appears, across the Adriatic, into Montenegro, whilst the lava flowed south and south-west through an enormous fissure in the old rim of the crater. On April the 9th and 10th, the wind had changed to the north-east, and when the collapse of the cone of the principal crater occurred, it was accompanied, or rapidly followed, by the ejection of steam and dust to a height of 22,000 to 26,000 feet. This changed the direction in which the dust was carried, and it now reached the shores of Spain; but on the 11th the cloud was impelled northward. On the 13th the giant cone was found to have a horizontal rim very little higher than Monte Somma, and with a crater about 1,000 feet in diameter, the cone being almost snow-white from the deposit of sublimates. Asphyxiation caused many deaths, and it was particularly noticed that when the lava-streams surrounded trees many of those which stood upright amongst the hot lava retained their leaves and blossoms apparently uninjured.

Changes in the Sea Level.

As showing possibly some submarine action in the way of subsidence of the bed of the sea, it was noticed that the sea-level was lowered, on the 7th and 8th of April, six inches, near Puzzuoli, and as much as twelve inches near Portici, and it had not returned to its previous level on April 18. More information on this head is certainly desirable. The alteration of a sea-level in a small tract, not observed beyond that tract, cannot remain permanently, and it remains to be seen whether the sea will resume its position. Otherwise, should it not prove to be the trough of a huge wave-undulation, which would afterwards change to a devastating wave thrown upon the land, the cause must be looked for in an elevation of the coast-line in question. It will have been noticed that Puzzuoli is one of the places to which reference is made, and the instance of the subsidence and subsequent re-elevation of the columns of the temple, said to have been dedicated to Jupiter Serapis, will at once come to mind, as having occurred at the same place.

Those who remembered the fine sunsets which occurred after the eruption at Krakatoa, in 1883, were on the watch for similar phenomena in April. Nor were they altogether disappointed. Some very fine sunsets were seen, but collected information on this head is required. Our readers will perhaps bear in mind that we shall be glad to receive records of such sunsets, with time, date, and place where observed.

Foreign Boulders in the Chalk.

Mr. G. E. Dibley, F.G.S., has been fortunate in discovering a fine mass of quartzite, weighing three pounds, in the chalk of Strood. The question of the method by which this and similar erratics were carried and dropped in the chalk-sea is a fascinating one. Various means have been suggested. Conveyance by means of ice is a likely explanation, whilst it has also been suggested that they may have been carried out to sea, entangled in the earth at the roots of storm-tossed trees wrenched from the soil of a neighbouring coast. Mr. Dibley's exploration of the chalk at Burham, near Rochester, has also resulted in the discovery of a fine set of teeth of *Ptychodus decurrens*, Ag. (*var. depressus*), from the zone of *Holaster sub-globosus*.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Ducks assuming Drakes' Plumage.

DR. C. G. SELIGMANN, the Pathologist to the Zoological Society, contributes an extremely interesting article to the columns of the *Field*, May 12, on the subject of the assumption of the male plumage by female ducks.

His observations were made on two domesticated birds, and extended over a considerable period. In both cases these birds for several years laid eggs and reared broods, but suddenly became sterile and gradually assumed the plumage of the drake, even to assuming the characteristic "eclipse" plumage. One of these birds, it is significant to note, did not enter on this abnormal phase until ten years of age, and the other at five years of age.

Both birds, on assuming the drakes' livery, refused all intercourse with males, but what is more curious, they assumed the conduct of males towards the females with which they were penned.

"As it has been found inconvenient," remarks Dr. Seligmann, "to have no single word to describe a bird which has assumed the plumage of the opposite sex, whether of the female or the male, or *vice versâ*. . . . I have ventured to term such birds alopterotic (ἄλλος, other: πτερωτός, feathered)."

Bittern in Devon.

Mr. C. H. Calmady-Hamlyn in the *Field* (April 14) tells how he unintentionally shot a Bittern (*Botaurus stellaris*) at Bridestowe, Devon, on January 11. He fired through a clump of thorns at what he believed to be a wild duck, but found on recovering his victim a Bittern. Fortunately the bird was only very slightly wounded in the wing. He therefore took it home and kept it a few days in his garden, where it quickly recovered and ultimately took its departure. The bird has since been seen several times by a friend of Mr. Hamlyn's, and it is hoped was not eventually killed.

Hoopoe in Kent.

The appearance of a Hoopoe on a garden lawn in Kent is certainly worthy of record. Mr. A. Randall Davis, who had the good fortune to be thus favoured on April 6, accordingly sent a short account thereof to the *Field* (April 14). The bird stayed until the 8th and then vanished; but during its stay appeared very tame, though mobbed at first by thrushes, blackbirds, and jackdaws. After an hour or two, however, "all had settled down quietly together." With a little encouragement, as we have before remarked, it is possible that this bird might be induced to live here regularly.

The issue of the *Field* for the following week (April 21) brought a note from Mr. Charles Ticehurst, who saw a Hoopoe on the Golf Links at Rye on April 7. Thus, if these birds escaped the gunners, it is possible that chance may have brought them together, since Hythe is not far distant, and in that case, assuming them to have been a pair, we may yet hear of another instance of the Hoopoe nesting in England.

Lapwings Swimming.

Though not generally known, it is a fact that the Lapwing (*Vanellus cristatus*) frequently takes to the water. On one occasion indeed a flock were observed resting on Lough Derg, co. Limerick, two miles from land, the wind blowing hard from the east. Apropos of this, Mr. H. W. Robinson contributes a note to the *Field* (April 21) to the effect that he has seen "young lapwings not long hatched swimming about in ditches like ducklings, and has also seen them land afterwards and run up to their parent." This fact is probably new to most of our readers.

Nesting of the Egyptian Plover.

The remarkable nesting habits of the Egyptian Plover (*Pluvianus ægyptius*) are by no means yet thoroughly understood. This bird has a habit of burying its eggs in the sand, but whether covered for the purpose of concealment, as the Grebes cover their eggs when leaving them, or whether they are left to be incubated by the heat of the sun, is not yet certain. Nor is it known whether birds which have been seen sitting on these eggs have first uncovered them, or whether, as has been suggested, they are merely protecting them from the intense heat of the sun. In the current number of the *Avicultural Magazine*, Mr. W. G. Percival contributes further testimony as to the burying of the eggs, but does not offer any suggestions on the above points.

Arrival of Summer Birds.

Going to Press early last month on account of the Easter holidays, we were unable to bring our list quite up to date, and herewith add a few further notes:—

Swallow—Seaton, Devon, April 3; Newhaven, Sussex, April 5.
Nightingale—Caterham, Surrey, April 7.
Black Cap—Stroud, Gloucestershire, April 6.
Whitethroat—Lancaster, April 8.
Sedge Warbler—Market Harborough, April 13.
Cuckoo—Surrender Park, Kent, April 11.
Wryneck—Guestling, Sussex, April 5; Cranbrook, Kent, April 6.
Nightjar—North Finchley, April 28. This abnormally early record is commented upon by Mr. W. B. Tegetmeier in the *Field*, May 12.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Absorption of Alpha Streams.

THE work on the products of Radium is now necessarily one of detail, in which gaps are being filled up or laws supplemented. Professor Bragg last year showed that the "stopping-power" of an atom of any gas for the Alpha streams was a constant of the atom, unaffected by its association with other atoms in molecular structure, and independent of temperature and pressure. The second of these statements implies that if we know the stopping-power of the constituents of a compound gas we find the value for the gas itself by simple addition. Not only so, but the stopping powers are very nearly proportional to the square roots of their atomic masses, so that a simple, if approximate, law covers all the phenomena. Professor Bragg has since extended these observations; and shows, moreover, that not only are the stopping-powers systematic, but show also a systematic deviation from the square-root law. For whilst depending mainly on the square roots of the atomic masses, they have a leaning towards the masses themselves.

This is shown by the following numbers selected from a much larger table in the *Philosophical Magazine* for May.

	Experimental Value.	Proportional to $\sqrt{}$ Atomic Mass.	$\cdot118\sqrt{m} + \cdot003\,m$
Hydrogen . . .	·243	·264	·242
Carbon dioxide .	1·47	1·51	1·48
CH_3I	2·58	2·35	2·52

In each of these columns the value for air must be taken as unity. The table shows clearly that closer correspondence with experiment is brought about by introducing the additional term.

The same law holds for substances in the solid state; thus the stopping-power is independent of the mode of aggregation. Now the Alpha particle expends energy in causing the expulsion of electrons from the atoms of any gas which it traverses. Since the expenditure follows the same law when the particles are massed together into a solid, it would seem that the solid must also become ionised, just as the gas is, and we should expect slow-moving electrons to be projected from Radium itself and from both sides of any solid screen through which the particles pass. These may be the slow electrons discovered by J. J. Thomson. This at least is Bragg's conclusion, and it is in conformity with Soddy's opinion. It must, however, be also borne constantly in mind that the slow-moving electrons supply the deficit which would otherwise appear of negative electricity. The emanation throws off a positive charge, and yet becomes itself positively charged (for it moves toward the *negative* terminal). Where is the corresponding negative charge if not in the more recently discovered slowly-moving electrons?

Standard Wave-lengths of Light.

It is now generally recognised that the efficiency of a diffraction-grating in the measurement of wave-lengths has been very much over-rated. Different first-class gratings give different values. A warning thrown out by Lord Rayleigh as early as 1888 against exaggerated expectations; there is now no doubt that the warning was justifiable. Attention has been directed in the last few years to methods based on the interference between the different beams which emerge after multiple reflections through a layer of air bounded by the two plain parallel surfaces of slabs of half-silvered glass. Methods such as this are usually distinguished as *interference* methods (such an arrangement is called an *interferometer*); but Lord Rayleigh is very emphatic in saying that such methods have no more claim to the title than the diffraction grating itself. In each method final effect is obtained by focussing to a point on a screen (or focal plan of an eye-piece) a succession of beams whose phases are different owing to the different paths travelled. The essential feature which distinguishes the parallel plate method is the greater simplicity which allows greater accuracy in construction.

Lord Rayleigh has modified the original arrangement of Fabry and Perot in the direction of simplification without apparently any loss of accuracy; and he has measured several of the leading standard reference lines in various spectra. It is noteworthy that in all cases Fabry and Perot's values are verified *to within one part in a million* and in some cases to considerably less. This is a most important result, since although it was well recognised that their values had been made with the greatest care and precision, yet they stood on their own merits. The present confirmation, by a modified method, proves that they deserved all the reliance which physicists were disposed to rest upon them.

Directed Wireless Telegraphy.

IN the ordinary systems of wireless telegraphy there is no means of knowing the direction from which the signals have arrived, or to send signal in one direction only. Theoretically it would be possible by means of a sufficiently large parabolic mirror to concentrate all the radiation along a single path; but the size of the mirror necessary for this would be heroic. This arises from the fact that very long waves are employed; for such waves the mirror must be proportionately large. It has now been found out by Signor Marconi and those working with him that when the "aerial" is placed horizontally instead of vertically, and with the spark at the end away from the sending station, a similar receiver picks up far more energy when the two are in one straight line. In this arrangement it is clear that it must be the magnetic component of the wave which is most efficient in producing the signal. This discovery would seem to mark a distinct advance in this important practical subject.

ZOOLOGICAL.

By R. LYDEKKER.

Habits of the Dugong.

SOME interesting notes on the habits of the Indian dugong, or sea-cow, are published by N. Annandale, of the Indian Museum, Calcutta, in the *Journal of the Asiatic Society of Bengal*, for last year. After stating that dugong feed largely on a green alga, as well as on a marine phanerogamous plant, the author proceeds to observe that the method of feeding does not appear to be the same as in manatis, which pluck the plants they eat by means of the two lobes above the upper jaw-pad, and push their food towards the mouth with the flippers. Similar lobes certainly exist in the dugong, but they do not appear in fresh specimens to be capable of any great degree of separation or movement, while the flippers are hardly long enough to give any assistance in feeding. As the upper jaw-pad (upper lip) itself, on the other hand, is evidently freely movable, and possibly to some extent extensile, it seems possible that it is used in plucking sea-weed, which certainly could be grasped between it and the lower jaw.

The author adds that, according to the fishermen, a single young one may be seen with a female at any time of the year; but on no occasion had they observed a female nursing its off-spring with one of her flippers, while her head and fore-part of her body were raised out of the water after the fashion supposed to have given origin to the mermaid myth.

Colour Evolution in Monkeys.

A paper in the current issue of the Zoological Society's *Proceedings* is devoted to the evolution of a remarkable type of colouring in the tropical African monkeys commonly known as guerezas, from the native name of an Abyssinian species. Starting from a wholly black species, a gradual transition can be traced to one in which the sides of the face, flanks, and hind-quarters, together with nearly the whole of the tail, are furnished with long fringes of pure white hairs, apparently developed to accord with the pendent white lichens clothing the branches of the boughs among which these monkeys dwell.

Ox-Warbles.

According to Mr. A. D. Turner, it is still unknown how the maggots which form the tumours known as "warbles" on the backs of cattle effect an entrance into the bodies of their hosts—whether by boring through the skin, or by being swallowed by the animals while in the egg-state, and subsequently eating their way through the walls of the gullet, and thus eventually reaching their final places of development. The point is an important one to cattle-owners, as "warbles" are a source of very serious loss alike to the butcher and to the dealer in hides and leather.

Aquatic Mice.

If we except the water-rat, the small mammals that have taken to an aquatic life in Europe and Asia are chiefly shrews, of which several distinct generic types are known, among them our own water-shrew. In South America, on the other hand, according to the researches of Mr. O. Thomas, of the British Museum, it is mice that have adapted themselves to this mode of life. Some years ago that gentleman described one of these water-mice, which feeds on small fishes, under the appropriate name of *Ichthyomys*; its home being the mountain-streams of Peru. Recently, he described a second, distinguished by the absence of ears, under the equally apposite title of *Anotomys*. Now, he has had the good fortune to be able to name a third as *Rheomys*, nearly allied to the second, but distinguished by the retention of ears and its glossy fur. From both the others, the first-named genus differ by the peculiar structure of its incisor teeth.

Papers Read.

At the meeting of the Zoological Society, on April 10 (the only one held during the month), Mr. C. T. Regan communicated a paper on Trinidad fishes; Messrs. Thomson and Henderson described alcyonarian zoophytes from Zanzibar; Dr. J. F. Gemmill discussed the phenomenon of "cyclopia" in trout-embryos and other fishes; while Mr. P. I. Lathy described certain butterflies.

REVIEWS OF BOOKS.

BOTANY.

Allen Flora of Britain, by S. T. Dunn, B.A. (West, Newman, and Co.; 5s. net.)—Most British botanists will probably be somewhat astonished to learn that the author considers 924 species, or practically half the number of British plants, as aliens, or in other words plants that have been introduced either directly or indirectly through human agency. The crucial test adopted is as follows: If a plant is found growing in perfectly wild and natural surroundings it is deemed indigenous, whereas if a plant only occurs in cultivated areas it is considered as an alien. This test dubs as indigenous all plants growing in elevated regions, or in localities that have for some reason not been disturbed by man, whereas broadly speaking, plants that grow in cultivated land, hedge-rows, &c., are introduced, or aliens. Now as the great bulk of land, say, below 500 feet elevation, has within the last thousand years been under cultivation at some time or other, and much of it almost continually so, it is difficult to conceive lowland plants as occupying other than cultivated areas if they succeeded in surviving at all. Many widely distributed plants now thoroughly naturalized, are undoubtedly aliens, having been introduced accidentally along with grain, wool, ballast, &c., and some of these have been with us for centuries; but before such a wholesale statement as to numbers can be accepted, stronger and more convincing evidence than is contained in the work under consideration will be required. Apart from the leading question, the book contains much useful information respecting the habitats and geographical range of the plants dealt with.

CHEMISTRY.

Treatise on the Effects of Borax and Boric Acid on the Human System, by Dr. Oscar Liebreich (translated from the German. London: J. and A. Churchill; pp. vii. + 70. 5s. net). An interesting series of experiments on living subjects was recently concluded by Dr. Wiley, of the U.S. Department of Agriculture, who arrived at the conclusion that borax and boric acid were undoubtedly injurious when used as preservatives in food. In this pamphlet, which is well illustrated with diagrams, Dr. Liebreich subjects Dr. Wiley's results to a critical examination, and comes to the opposite conclusion. He considers that any injurious symptoms observed were due to unsuitable hygienic conditions and to the choice of unsuitable persons for the experiments, and not to the effect of the borax. The pamphlet will be read with interest by those who are interested in the subject, but it shows the necessity of much more work being done before a definite conclusion can be formed. It may be mentioned that the Parliamentary Committee on Preservatives, in this country, came to the same conclusion of "not proven," as Dr. Liebreich, notwithstanding some strong medical evidence in the other direction, and recommended that a small proportion of boric acid should be permitted in butter, cream, and hams. The question, however, is still unsettled, and no tradesman who ventures to use boric acid can consider himself safe from prosecution. In fact, so chaotic is the law that quite recently a shopkeeper, summoned for selling preserved food in one borough, called the Medical Officer of Health from an adjoining county as a witness for the defence, and won his case. This pamphlet of Dr. Liebreich is also likely to appear frequently as a witness for the defence in similar cases, which will continue until such time as we have the matter properly thrashed out and the use of preservatives either legalised or made illegal.

ETHNOLOGY.

Mexican and Central American Antiquities, Calendar Systems, and History. Twenty-four papers. By E. Seler, E. Förstemann, P. Schellhas, C. Sapper, and E. P. Dieseldorff, Smithsonian Institution, Bureau of American Ethnology. Bulletin 28, Washington, 1904. The late Director of the Bureau of American Ethnology was very well advised when he determined to publish translations of a number of foreign papers on the archæology and glyphic writing of the semi-civilised peoples of middle America. These have now been published under the supervision of Charles P. Bowditch, and they afford to the ethnologist a mine of information on subjects to which otherwise he could obtain access only with the greatest difficulty. One has only to glance at this well illustrated book to see that it is of interest not merely to the Americanist or archæologist, but also to the general ethnologist. The latter, however, will have to search for his material, as most of it is scattered all over the volume, and pick out what he requires from papers of diverse kinds, but in some cases, as in the articles on the priesthood, ceremonials, deities, and religious conceptions of the Zapotecs, he will find it pretty fair sailing. In a new subject, such as this, and dealing with interpretations based on glyphs which have no "Rosetta Stone" to guide them, authorities are apt to differ from each other, and to modify their own previously expressed opinions, thus the reader must be continually on the watch for these pitfalls. Mathematicians and those who like number puzzles will find full scope for their ingenuity in the consideration of the Maya Calendar. According to a widespread tradition, the Toltec nation was the originator of all arts and sciences, and among other things the invention of the calendar is ascribed to them, and we are told that they carried their books with them on their migrations. The calendar is the alpha and omega of the Central American sacerdotal wisdom, and the great mass of Mexican and Maya manuscripts is nothing more than an elaboration of this calendric system in respect of its numerical theory, its chronology, and its system of divination. The nature of this calendar, consisting in the fact that it originated from the fundamental number 20 in combination with the number 13, is well known. A simple calculation shows us that the peculiar period of 52 years in use among the Mexican races proceeds directly from the application of this fundamental system to a solar year of 365 days. There is still a diversity of opinion as to how far the Mexicans themselves were able to harmonise this system with actual time, the solar year, and the revolution of the various heavenly bodies. Among the Maya races the system seems to have been brought to perfection on the numeric-theoretic side in particular. It seems certain that not only the movement of the sun, but also the movements of the large planets were noted, and that these people were capable of connecting the period of revolution of these bodies with the solar year of 365 days, and with the period of 20 × 13 days, the true basis of the system. The apparent period of revolution of Venus may be set down with tolerable accuracy as 584 days. Five such revolutions give us the figures of 2,920, or eight solar years of 365 days. This precise number is plainly the basis of the computations on certain pages of the Dresden manuscript. But 65 such periods give us the number of 37,960, that is, double the period of 52 years, which is the direct result of the application of the designation of days in accordance with the system of the 20 characters and the 13 digits to the solar year of 365 days. In like manner the revolution of Mercury around the sun, which is completed in 115 days, seems to be brought into connection with the period of 20 by 13 days; for 104 of these revolutions produce the number 11,960, which is also forty-six times the period of 20 by 13 days; and this number clearly forms the basis of other pages in the Dresden manuscript. Unfortunately, it is almost hopeless to look for an exact chronology in the native manuscripts or monuments, but several acute scholars are working hard at these difficult glyphs, and the publication of this book will enable others to follow their labours with greater ease.

Haida Texts and Myths, Skidegate Dialect. Recorded by John R. Swanton. Ibid. Bulletin 29, Washington, 1905. A very considerable number of folk-tales have already been collected in North America, but Prof. W. H. Holmes, the chief of the Bureau of American Ethnology, in succession to the late Major Powell, rightly considers that the whole of it should be collected and published, as they form a very important element in the ethnological study of a people, especially when, as in this case, the tales are given as literally as possible. Many of the tales are printed also in the vernacular, and thus they have a philological value in addition to the insight they give into the religious ideas of the people. One is impressed by these tales by the tremendous hold spiritual power has over the imagination of these as of most other North American peoples, for success in life is attributed to it in the same manner that the Melanesians regard all good fortune as the result of Mana, a term which an American would translate as "medicine." Incidentally these tales throw light upon the social and daily life of the natives.

GEOLOGY.

The Founders of Geology, by Sir Archibald Geikie, F.R.S. (Macmillan and Co., pp. 486, 10s. net). We are glad to see this work in a second edition, covering as it does ground which to many is as a sealed book. Geology becomes the more interesting when one studies the work of pioneers of the science, and the obstacles which they had to overcome. Opportunity has been taken to considerably extend the scope of the edition of 1897, and to give a sketch of the progress of geological ideas from the times of Ancient Greece onwards. Naturally, the greater part of the book is taken up with the lives of leaders of the 19th century, in the halcyon days of the science, whilst in the period approximating to the present day the men famous in geological discovery are so numerous that the narrative has of necessity to be confined to the mention of but a few. Perhaps contemporary geologists will form the subject of another volume, and among the first to be mentioned in such a connection will be that of the author.

E. A. M.

METEOROLOGY.

Meteorology in Mysore for 1904, being the results of observations at Bangalore, Mysore, Hassan, and Chitaldrug. Twelfth Annual Report. This publication, by John Cook, M.A., F.R.S.E., &c., director of meteorology in Mysore, is worthy of the "Model State," containing as it does in addition to the ordinary features associated with an annual meteorological volume, a complete and comparative summary for the whole 12 years of the establishment, which is also a model in itself, the four stations, at the corners of a not quite regular quadrilateral, having been founded successively in a little more than a year (Bangalore observations commencing April 1, 1892, and Mysore, May 10, 1893), and being provided with similar staffs and equipment, so that the work is readily comparable. For Government purposes the formula adopted to give daily mean temperature is apparently considered insufficient, a second formula called the Government of India mean being also employed for official purposes. India, however, is too large a district for an empirical formula to be of universal application, and it is obviously not quite right for Mysore. It would seem better to determine the daily variation for every district separately, if not for every observatory, as is done for some British stations, for instance, and use that instead of the Government formula. Some interesting features from our insular point of view may be noted in connection with the actual results. The extreme range of the barometer for the year is only about half-an-inch, but as all the stations are high (2,400 ft. to 3,100 ft.), and tropical, this is more a matter for satisfaction than surprise. The maximum temperature for the year was 94°.0 at Hassan, 97°.3 at Bangalore, 99°.9 at Mysore, and 100°.3 at Chitaldrug, all on different dates. The minimum readings being respectively 46°.5, 51°.0, 53°.2, and 55°.3, also on different dates, and only two in the same month. It is fairly dry, the humidity at each station running down to nearly 10. The actual figures are 9, 10, 12, 13. There is not much wind, the greatest daily movement being 462 miles at Mysore, that at Hassan never exceeding 175 miles; the total rainfall at the wettest station, Bangalore, being 31½ inches, and at the driest, Chitaldrug, 23 inches; Hassan, however, heading the list of wet days with 111 and of daily fall with 3½ inches. There are instructive plates giving curves of daily mean barometer, dry bulb, wet bulb, maximum and minimum temperature, rainfall cloud, wind velocity, and direction for each of the four stations, and also six-day and monthly mean curves for several elements compared with those for Madras. We may congratulate the model state on having secured a model director, and the director on the opportunity of continuing a work which will grow in value with every year, in a climate which for many reasons seems eminently fitted for meteorological investigations.

SCHOLASTIC.

Elementary Electrical Calculations. W. H. N. James and D. L. Sands (Longmans and Co., 3s. 6d. net). This consists in details of calculations such as an electrical engineer requires to make. It is the outcome of a number of lectures on such calculations and is intended as supplementary to much class work. The calculations are of an elementary nature, and for this reason there are none in connection with alternating currents, self-inductance, and capacity, the properties of which can be adequately studied only by a senior student. We think, however, that in this elementary book it would have been very advantageous to deal with some electrostatic problems without which a student will never thoroughly understand the part played by condensers in alternating work.

The treatment here is accurate; but it must be understood that the theory underlying the calculations is not given; for this the reader must have recourse to other text-books or to class teaching. The solution in many cases is obtained by means of curves; these certainly prove of great aid in enabling one to understand the variation of any quantity.

First Stage Physiography (Section I.), by R. Wallace Stewart, D.Sc. "The Organised Science Series." (University Tutorial Press, Ltd., pp. 256, 2s.) This section deals with mechanics, physics, and chemistry, with experiments, questions, and answers to each part. It is a useful and reliable little handbook, and we are able to give the same commendation to this as to others of the same series which have been mentioned in these columns. It is fully illustrated with diagrams of a useful and appropriate nature. E. A. M.

A new catalogue of educational books has just been issued by W. A. Foyle, 135, Charing Cross Road, henceforward to be known as W. and G. Foyle. Considerable extensions of the firm's business are in progress, and separate catalogues are to be issued for civil service, university, banking, law, medical, and theological books.

Taylor's Card Calculator.—An ingenious card calculator has been devised by Mr. J. W. Taylor, of Leicester, for the purpose of the mechanical addition or subtraction of all the fractions of an inch which are multiples of the negative powers of 2, from $\frac{63}{64}$ to $\frac{1}{64}$. The device, which is manipulated by the movement of a quadrant on a semi-circle, is very easy to understand, and appears to be likely to be extremely useful in the drawing office. Decimal equivalents of all the fractions are added, together with much useful information for engineering draughtsmen.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 440.)

The plate used in photo-micrography should be, therefore, an orthochromatic one, it should be of medium rapidity in order to get contrast and latitude of exposure, and it should be "backed" to save reflections. There are many such plates on the market, the Edwards, Barnet, and Ilford plates are all well known: the first is, perhaps, the most popular, but according to some very interesting tests made by Dr. Spitta, the "Isochrom" plate of the Ilford Company has a wider range, and is, therefore, superior. The Lumière plate is rather more expensive, and the Cadett plate has the largest range of all, but is awkward to develop on account of this very sensitiveness. It is well to make a practice of using one kind of plate and to adhere to it except for some special reason.

The necessary screens will be two yellow screens, one of them dense, two blue screens of the same description, and a signal-green or pot-green screen. Gifford's F line screen is a very useful one, whether made of glass and gelatine or of signal-green glass and malachite green and glycerine, which passes more light.

The question of exposure is a difficult point to give hints upon, as it varies enormously with the light, the plate, and the objective and magnification, and I am afraid nothing but trial and experience will be of service. Two things may be said, however; firstly, that orthochromatic plates of medium speed have extraordinary and unexpected latitude in this respect, and, secondly, that in case of over or under exposure it is a fairly safe rule to boldly halve or double the exposure, as indicated by the state of the plate on development, and not to try intermediate differences of time. Perhaps a few examples of exposures taken from my own record book may be some little guide to an absolute beginner. Thus, with lamp-light and a Herschel auxiliary condenser, in addition to the sub-stage condenser, without screens, with a projection eyepiece x3, and a moderate camera length, a 1-inch objective required 45 seconds exposure, and a $\frac{1}{6}$-inch objective about three minutes; whilst with the oxy-hydrogen light and a Conrady achromatic and aplanatic condenser, a 1-inch objective required 10 seconds, and a $\frac{1}{4}$-inch 45 seconds. The use of screens would double or treble these exposures, and the nature of the object may also make much difference.

The developers differ somewhat from ordinary photography, as we require not soft graduations, but sharp blacks and whites. The best developer I know of for this purpose is metol and hydroquinone, but for particulars as to the use of this I must refer the reader to ordinary books on photography, merely observing that development should be carried beyond the stage required for ordinary work. Whatever developer is used, however, it should be mastered and adhered to as a general rule. Intensification and reduction are valuable aids in modifying or improving otherwise unsatisfactory negatives.

The best paper is a Bromide paper, amongst which "Nikko" is excellent for our purpose. Printing-out papers are less satisfactory, especially for reproductive work for the press, but are capable of being watched and humoured rather more, and are useful also for rough trials.

These notes have already run to a greater length than I originally intended, but I have tried to keep them as elementary as possible, and to refrain from going into too much detail, though it has been a constant temptation to enlarge on the many important points dealt with. I hope I have, however, explained the essential points which a beginner needs to know.*

Royal Microscopical Society.

April 18—J. C. Karop, Esq., M.R.C.S., Vice-President, in the chair. Dr. Hebb exhibited and described a simple and effective form of apparatus for obtaining blood for bacteriological examination and cultivation. He also showed some cultures of bacteria on blood serum and agar, which were preserved in formalin. The cultures were killed, and at the same time mounted, by pouring into the test-tube 10 per cent. formalin on the top of which was placed a mixture of melted paraffin and vaseline. When cool, this formed an air-tight and stable cylindrical stopper. Dr. Hebb remarked that the method was not adapted for all cultures, as some were dissolved off the surface by the preservative fluid. Dr. Hebb also exhibited some test-tubes containing sterilised nutrient broth plugged in the same way. The object of the plug was to allow the tubes to be transported from place to place without damage to or loss of the medium. To remove the plug it was only necessary to warm the tube. A series of coloured lantern slides of botanical sections by Mr. Flatters, of Manchester, were shown.

Quekett Microscopical Club.

April 20—the President in the chair. The Hon. Editor, Mr. F. P. Smith, brought forward two papers. The first, "On the Spiders of the *Diplocephalus* Group," concluded the revision of the British species of the subfamily Erigoninæ. The second paper was a catalogue of the literature dealing with Erigonine spiders.

Mr. H. Taverner, F.R.M.S., gave an account of the methods he employed in stereo-photomicrography. The axial rays were found to be detrimental to the formation of a stereoscopic image, and after considerable experiment a form of Davis's shutter is now employed, fitted above the objective and able to be shifted by screw adjustment to a maximum of 4 mm. either side of the optic axis. To obviate cutting the prints for mounting, a repeating back is used and the image received on the left half of the plate, with the aperture of the stop to the left of the optic axis, and the second exposure on the right half of the plate with stop to the right of the optic axis. The diameter of the aperture was usually $2\frac{1}{2}$ mm., with its inner edge not more than 1 mm. from the optic axis.

The Hon. Secretary read a paper on the same subject by Mr. W. R. Dollman. Only low powers are used—photo objectives with focal lengths of from two to six inches being employed. A semi-circular shield is placed against the diaphragm between the combinations and rotated through 180° between the two exposures. Acetylene is used as illuminant.

Mr. J. Rheinberg, F.R.M.S., read a long and technical paper dealing with "Stereoscopic Effect, and a

* The first instalment appeared in "KNOWLEDGE," for November, 1905

Suggested Improvement in Binocular Microscopes." It was shown that by means of a stop with circular apertures placed between the objective and the prisms in an ordinary binocular, definition was greatly improved. Wenham and Stevenson forms of binocular microscopes were exhibited with and without the stops suggested. A Greenough binocular with separate objectives and a stand fitted with the Abbe stereoscopic eyepiece were also on the table.

Creosote as a dehydrating medium for embedding in Paraffin.

W. Pavlow recommends the following method of dehydrating tissues prior to embedding in paraffin, instead of the usual method with alcohol: The objects may be fixed in any kind of fluid, and are then transferred, without any other previous dehydration, to creosotum fagi for 4 to 24 hours, according to their size, and finally put into pure creosote for two or three hours longer. On removal the superfluous creosote is taken up with blotting paper, the objects are soaked in xylol or toluol for an hour, and then embedded in paraffin as usual.

Carl Zeiss' New Catalogue.

The 33rd edition of Messrs. Zeiss' new catalogue has just been issued and shows certain modifications from former editions, more especially with regard to microscope stands, certain models having been withdrawn, and others added. To their larger stands Messrs. Zeiss fit their new "Berger" form of micrometer fine adjustment, which is a great improvement on the older form, the consequent alteration in the limb enabling them to add also a convenient, yet unobtrusive, handle for lifting the microscope. The provision of such a handle is, however, even more necessary in the older form of microscope where the whole limb, instead of being fixed as in the above models, is borne upon the upright triangular bar of the fine adjustment, for it is by this limb that the average student persists in lifting his microscope. A new upright stand for rough laboratory use has been added, which is fitted with a coarse adjustment only, corresponding to similar stands made by Leitz and other makers. Perhaps of even more interest, however, to the general microscopist is the fact that in the present catalogue Messrs. Zeiss have considerably reduced the prices of many of their achromatic objectives, the old D of $\frac{1}{6}$-inch focal length, for instance, being reduced from £2 2s. to £1 15s., and the 1-12th inch oil immersion from £8 to £6 5s. The Huygenian oculars, nose-pieces, &c., show corresponding reductions. The apochromatic objectives and compensating oculars, unfortunately, are not reduced in price, and amongst the former we note that the one inch of .3 N.A., formerly supplied for the 10-inch tube, no longer appears. Apart from its own interest, the catalogue contains much valuable information on optical matters, set forth in a lucid and instructive manner, but I regret to see that Messrs. Zeiss continue (on page 10) to give inaccurate magnifications for the compensating oculars as used for the Continental length of tube, and to state that when these are used for the 10-inch tube "to obtain correct *ocular* magnification (the italics are my own) it is necessary to multiply the figures engraved on the oculars by 1.5." Of course, the ocular magnification does not vary at all under such circumstances, and it is the objective magnification that needs to be multiplied by 1.5, the total magnification of ocular plus objective giving the same result whichever method of working be adopted. The practical disadvantages of the former system are that it leads to much confusion of thought—as only those who, like myself, have frequently to answer questions on the subject fully realise—that it is incorrect, and, therefore, unscientific, and that it causes a worker to underrate by 50 per cent. the power of the ocular which he is using and the consequent strain which he is putting upon his objective. I hope that in the next edition of the catalogue this small, but not unimportant, matter will receive attention.

Microscopical Material.

Mr. W. S. Rogers, of Slough, is good enough to send me for distribution some shore scrapings from Adelaide, South Australia. The quantity is, unfortunately, limited, but I shall be glad to send some to the first applicants who send me a stamped and addressed envelope, and a very *small* box, to prevent crushing of the shells. Applications must be accompanied by the coupon to be found in the advertisement pages of this issue, and as I can only supply the first-comers in rotation until the material is exhausted it will be seen that early application is necessary. I shall, however, keep a small quantity for foreign readers. I am always grateful for any microscopical material for distribution, and hope that any of my readers who can assist me in this way will do so.

Notes and Queries.

Diatomaceous Deposit.—Mr. T. W. Robertson, Glasgow, who is much interested in diatoms, would be grateful if any reader could assist him to get some diatomaceous deposit from the province of Simbrisk, Russia, and from Sendai, Japan. Mr. Robertson would be glad to defray any expense, or to know of anyone likely to supply his wants.

Volcanic Dust from Mont Pelee Eruption.—The Rev. W. Hamilton Gordon, Fareham, Hants., would be glad if any reader could give him any information as to the requisite treatment for volcanic dust, and as to what points of interest there are in such dust.

Mounting Diatoms in Realgar.—Replying to W. H. B., Leicester, Mr. Basil F. T. Tryon kindly sends me the following, echoed from an article by Mr. J. W. Gifford in the "Illustrated Annual of Microscopy" for 1898: "Realgar is prepared by heating together equal parts of clear red realgar and stick brimstone (flour sulphur is apt to be full of dust). In order to prepare the mount a drop of the solution containing the diatoms must be dried on a very thin cover-glass by passing it, diatoms uppermost, through the flame of a spirit lamp. A small piece of the medium is then placed on the glass slide, which is carefully warmed in the same way by passing to and fro through the flame until the medium melts, and while both are still in the flame of the lamp, the cover is turned over and carefully lowered until contact is made with the medium. As soon as it has spread out to the edges a clip must be put on, or the medium will crack off in cooling, which must take place very gradually. The best thing is to put the mount, still hot, into a small tin box, previously warmed, and place the whole in a vessel of boiling water and put aside to cool. The water must, of course, not touch the mount. There will be many failures; but when a good mount is made it will be well worth the pains taken. This medium is very yellow, but this is no objection." Mr. Tryon adds, "I have been told that the making of realgar mounts is very dangerous, on account of the arsenic fumes given off in heating. They should be prepared in the open air and in fine weather. Damp ruins them. Ring with Hollis' glue."

C.M., Tunbridge Wells.—I am informed that the fungi in the slide you have sent me are *Tripospermum* [illegible], one of the Dematieæ. They have apparently not been yet worked out and are consequently put amongst the Fungi Imperfecti, whose life history is not known.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for June.

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

THE SUN.—On the 1st the Sun rises at 3.51 and sets at 8.4; on the 30th he rises at 3.48 and sets at 8.18.

Summer commences on the 22nd, when the Sun enters the sign of Cancer at 9 a.m.; this is the longest day, the Sun being $16^h\ 34^m$ above the horizon. The equation of time is negligible on the 15th, hence this is a convenient day for adjusting sundials, as only the correction for longitude is needed. Sunspots and prominences appear to be slightly on the wane, but at this period of solar activity the disc is rarely devoid of spots.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point	Centre of disc S. or N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 31 ..	16° 12′ W	0° 37′ S	96 58′
June 5 ..	14° 18′ W	0° 1′ S	30 48′
,, 10 ..	12 18′ W	0 35′ N	324 38′
,, 15 ..	10° 12′ W	1 12′ N	258 28′
,, 20 ..	8 1′ W	1° 47′ N	192 15′
,, 25 ..	5 48′ W	2° 21′ N	126 5′
,, 30 ..	3 32′ W	2 55′ N	59 54′

THE MOON:—

Date.	Phases.	H. M.
June 6 ..	○ Full Moon	9 12 p.m.
,, 13 ..	☾ Last Quarter	7 34 p.m.
,, 21 ..	● New Moon	11 6 p.m.
,, 29 ..	First Quarter	2 19 p.m.
,, 6 ..	Perigee	5 12 a.m.
,, 18 ..	Apogee	10 12 p.m.

OCCULTATIONS.—The following occultations are visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.
			p.m.		p.m.	
June 5	49 Librae	5·6	7.57	125	9.0	276
,, 7	μ Sagittarii ..	4·0	10.45	110°	11.51	259

THE PLANETS.—Mercury (June 1, R.A. $3^h\ 56^m$; Dec. N. 19° 57′. June 30, R.A. $8^h\ 8^m$; Dec. N. 21° 53′) is in superior conjunction with the sun on the 8th, and hence the planet is unobservable. Towards the end of the month the planet is an evening star in Gemini, and may be observed immediately after sunset low down in the N.W.; on the 25th the plant sets at 9.40 p.m. or $1^h\ 20^m$ after the Sun.

Venus (June 1, R.A. $6^h\ 31^m$; Dec. N. 24 44′; June 30, R.A. $8^h\ 59^m$; Dec. N. 19 2′) is an evening star in Gemini, setting about 2 hours after the Sun throughout the month. The planet is pretty bright and should be looked for shortly after sunset, it will be found in that portion of the sky illuminated by the afterglow of the setting Sun.

The apparent diameter of the disc is 12″·5 and it appears gibbous, 0·84 being illuminated.

On the evening of the 24th the planet will appear in proximity to the crescent Moon, Venus being 2½° to the north.

Mars (June 1, R.A. $5^h\ 30^m$; Dec. N. 24 3′. June 30, R.A. $6^h\ 54^m$; Dec. N. 23 49′) is practically unobservable as he sets very shortly after the Sun.

Jupiter (June 1, R.A. $5^h\ 2^m$; Dec. N. 22 23′; June 30, R.A. $5^h\ 31^m$; Dec. N. 22° 56′) is in conjunction with the Sun on the 10th, hence the planet is unobservable.

Saturn (June 1, R.A. $23^h\ 6^m$; Dec. S. 7 44′. June 30, R.A. $23^h\ 8^m$; Dec. S. 7 39′) is a morning star, rising about midnight near the middle of the month. The planet is at the stationary point on the 27th, after which date he continues to describe a retrograde path in Aquarius for the next four months.

Uranus (June 15, R.A. $18^h\ 31^m$; Dec. S. 23 35′) rises about 9 p.m. near the middle of the month, and is on the meridian about 1 a.m. The planet is in opposition on the 29th, but he is not well placed for observation as he is situated low down in Sagittarius.

Neptune (June 15, R.A. $6^h\ 41^m$; Dec. N. 22° 14′) is out of range for observation, as early next month he is in conjunction with the Sun.

METEOR SHOWERS:—

Date	Radiant. R A	Radiant. Dec	Name.	Characteristics.
	h. m.			
June—July..	16 48	−21°	α Scorpiids	Fireballs.
June 13 ..	20 40	+61	α Cepheids	Streaks, swift.

TELESCOPIC OBJECTS:—

DOUBLE STARS, &c.— Scorpii, $XVI.^h\ 0^m$, S. 19 33′, mags. 2·7, 5·2; separation 13″·1.

ε Lyra, $XVIII.^h\ 41^m$, N. 39 33′, known as the "double-double" star, can just be separated by the naked eye, but with a pair of opera glasses it is readily divided into two components ϵ_1 and ϵ_2, mags. 4·4 and 4·8. Using a 3-in. telescope and a power of about 120, each of these stars can again be divided into pairs, 3″·2 and 2″·6 apart respectively, each component being about magnitude 5·5.

M 57 (Lyra), the "ring" nebula. This nebula is the only annular nebula accessible to telescopes of about 3-in. aperture, and even then requires good seeing. It is easily found, being situated about ⅓ of the distance from β to γ Lyræ. The usual appearance in a 3-in. telescope is that of a rather large nebulous star, but it bears magnification well, and its annular character can easily be made out with a moderately high power.

M 80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

Temperature of the Hemispheres.

THE Southern Hemisphere as a whole is colder than the Northern Hemisphere, and a new determination of the mean temperatures has been made by M. Julius Hann in the *Lehrbuch der Meteorologie*. In Southern latitudes the annual temperature varies from 5·5 deg. C. in Lat. 50 deg. to 20 deg. below freezing in Lat. 80 deg. The mean annual temperature of the Southern Hemisphere is 13·6 deg. C., and ranges from 17·3 deg. in January to 10·3 deg. in July. In the Northern Hemisphere the mean annual temperature is 15·2 deg. C., and ranges from 8 deg. C. in January to 22·5 deg. C. in July. In the higher latitudes the differences of temperature seem to be accentuated in the direction of a general lower temperature for the South. The mean annual difference of temperature between the two Hemispheres is about 1·5 deg. C.

Knowledge & Scientific News

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Holes in the Heavens.

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

THERE are many dark spots in the Milky Way which seem to be openings or holes in that wonderful zone of stars. These dark spots or "coal sacks," as they are also called, seem to have been first noticed by Pinzon, in 1499. They were also described by Lacaille in 1763.

The most remarkable of these spots is the well-known "Coal Sack" near the Southern Cross. It is of roughly oval or "pear-shaped" form, about eight degrees in length by five degrees in width, and forms a conspicuous object in the sky of the southern hemisphere. It is completely surrounded by the nebulous light of the Milky Way, which is here of considerable brilliancy. The bright stars α and β Crucis—the brightest stars of the Southern Cross—nearly touch its south-eastern edge. It contains only one lucid star within its boundaries. With reference to its northern border, Sir John Herschel says: "The transition from rich Milky Way to almost complete darkness is here very sudden." It is, however, by no means devoid of faint stars. On a photograph taken in 1891 by Mr. H. C. Russell, at the Sydney Observatory, numerous very small stars are visible, but there are several spots which seem to be completely void of stars, and absolutely black. One of these remarkable holes is near β Crucis, and another near α Crucis.

There are other remarkable "coal sacks" in the Milky Way. A long, narrow, dark spot runs from α Centauri, for several degrees towards the north-east. There are several in Scorpio, one of larger size between β and ϵ Cygni, and one south of α Cygni.

Examined with a telescope, the Milky Way shows many examples of small coal sacks; and some may be seen with even a good binocular field glass. One night when Sir William Herschel was examining a part of the Milky Way closely east of the globular cluster 80 Messier, which lies between ν and σ Scorpii, he suddenly exclaimed to his sister—the famous Caroline Herschel—"Hier ist wahrhaftig ein Loch im Himmel" (Here, truly is a hole in the Heavens). It was an absolutely black vacuity, about four degrees in width, perfectly free from any stars, and especially remarkable owing to its proximity to one of the richest globular clusters in the heavens. Closely south of Herschel's dark "hole" just mentioned, Professor Barnard has photographed a great nebulous region surrounding the stars ρ Ophiuchi and 22 Scorpii.* This photograph shows several dark lanes in what seems to be at least a comparatively thin sheet of stars, and this distinguished astronomer thinks "it is certain that these stars are at the same distance as the nebula, for they form part of it." With reference to the Milky Way in general, he thinks that the stars comprising it are "comparatively very small bodies, and that they consequently differ vastly in point of size, at least, from the ordinary stars of the sky." If this be so, and the evidence seems to point in this direction, it would follow that their distance from the earth is not so great as their faintness would lead us to imagine. In his *Cape Observations*, Sir John Herschel gives a list of 49 spots in the southern hemisphere "totally devoid of any perceptible star." But probably photography will reveal the presence of some faint stars in these dark spots.

Closely east of the star θ Ophiuchi is a "dark chasm," which passes south and west of that star, and there are several other dark "lanes" and holes clearly visible on the photograph taken by Professor Barnard at the Lick Observatory.

Another small black spot was observed by Barnard a little north-west of the star γ Sagittarii. This seems to have been previously seen by Trouvelot, who says: "C'est comme un sac à charbon en miniature, ou une ouverture de la Voie lactée à travers laquelle la Vue pénètre au delà de ce grand assemblage d'étoiles."

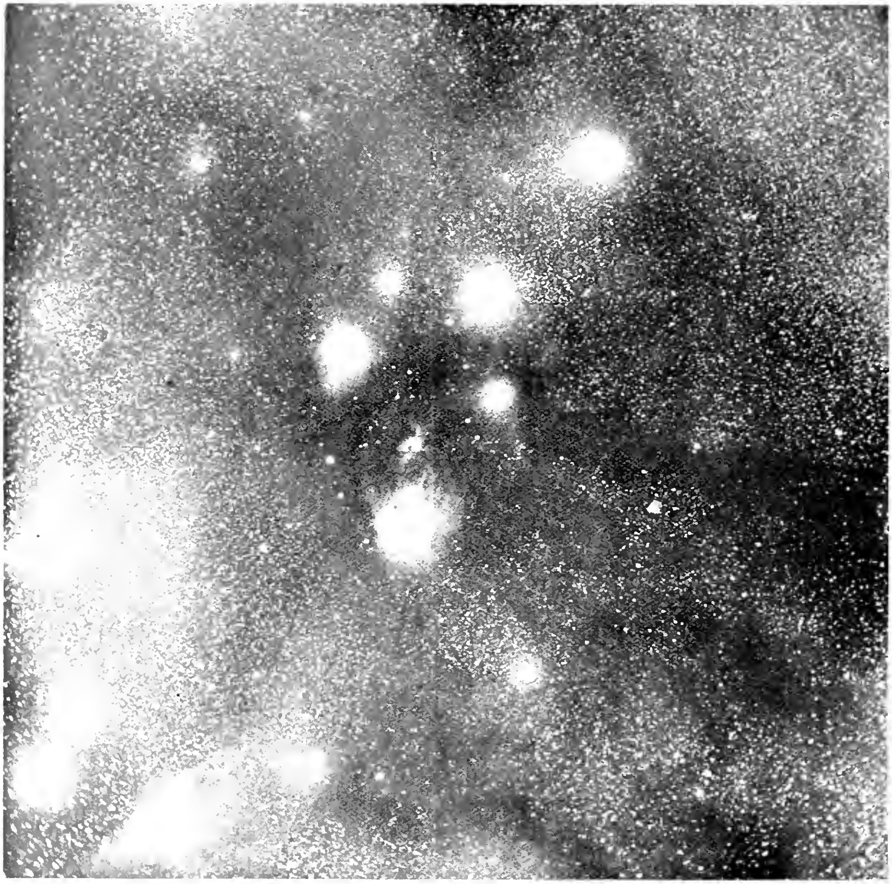
A little south-east of α Cephii, a photograph by Barnard shows a ring of nebulous light, with a comparatively dark interior, at least the stratum of stars filling the rings seems pierced by several holes.

The "key-hole" openings in the great nebula surrounding the variable star η Argûs is a remarkable feature of that wonderful nebula. A little south of this hole there is a "kidney bean" shaped opening, shown in Sir John Herschel's drawing in the *Cape Observations*. This opening is visible on a photograph taken by Sir David Gill in March, 1892. The photograph confirms the accuracy of Herschel's drawing, and shows that the opening is in all probability a real hole through the surrounding nebulous matter.

In the region round the star 12 Monocerotis there is a remarkable nebula of irregular shape, somewhat resembling in its general character the great nebula in the "sword" of Orion. Dr. Roberts, describing a photograph he took of this nebula, says: "Some remarkable tortuous rifts meander through the nebulosity on the *north preceding* half of the nebula; their margins

* The rings round the brighter stars in the photograph are due to a photographic effect, and do not exist in the sky

are sharp and well defined in the midst of dense nebulosity. They are as clearly cut as we see the canyons of great rivers, but their width may in reality be millions of miles, for we have no reason to assume that the nebula is nearer to the earth than the stars. It is, indeed, possible that the stars which dot the surface are nearer to us than the nebula.''



Great Nebula near ρ Ophiuchi.

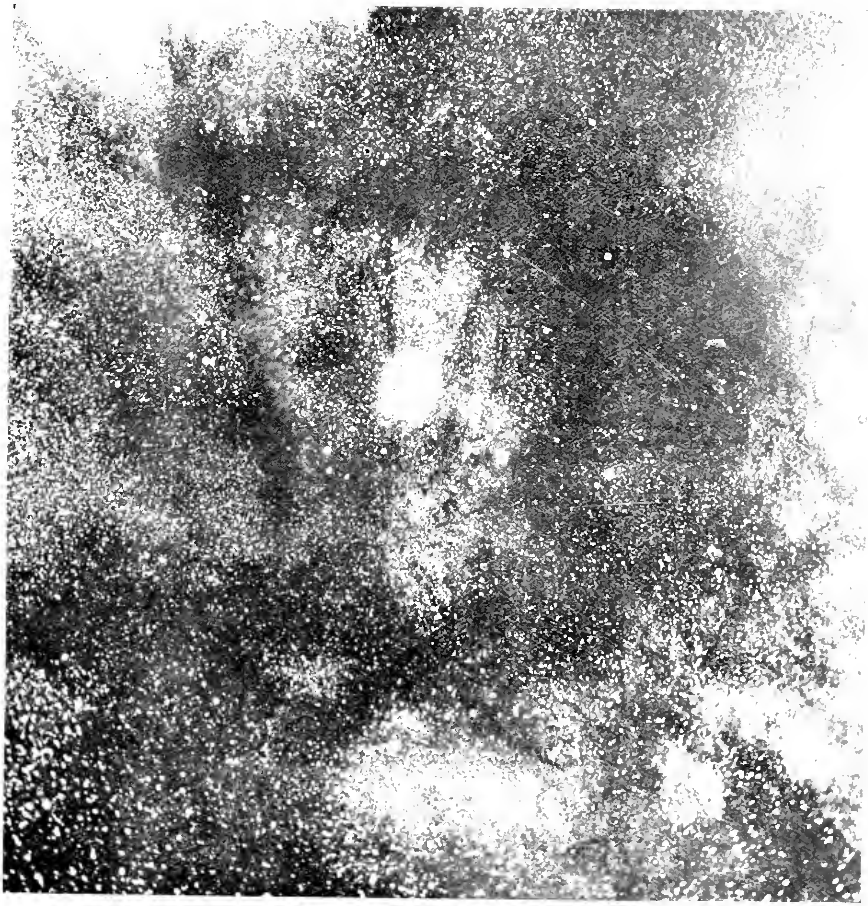
(From a photograph by Prof. E. E. Barnard, of the Lick Observatory.)

About 3 degrees north-east of the star θ Canis Majoris is another nebula of irregular shape. Dr. Roberts says that the star D.M. 1848 "is on the margin of a dark sinuous vacancy or rift in the nebula, through which we see into the starless vacancy of space beyond it.'' This opening closely resembles the "keyhole'' opening in the great nebula in Argûs. Dr. Roberts adds: "These vacancies are most conspicuously seen where the surrounding nebulosity is dense, though they are also visible in some parts where it is relatively faint. The margins of the vacancies are often sharply defined, and suggestive of the idea that in consequence of some internal strain, operating from opposite directions, the nebula was rent asunder, and the parts separated from each other.''

In another nebula in Monoceros, photographed by Dr. Roberts, a little west of the triple star 15 Monocerotis, there is a remarkable vacuity or hole. Dr. Roberts calls it a dark tortuous rift, and says: "The rifts prove that the nebulæ are not globular, but are like clouds with relatively small depths, and that we can see through them into the darkness of space beyond." There are also very noticeable areas devoid of stars in the region surrounding the nebula.

On July 12, 1891, Professor Max Wolf, of the Astrophysical Observatory of Heidelberg, discovered three dark markings in the Milky Way, about 1½ degrees west of the star γ Aquilæ. He calls them the "Triple Caves,'' and they certainly present a very remarkable appearance on his photograph. Closely east of the same star, a photograph taken by Barnard shows some curiously shaped dark markings, which seem to be openings through the Milky Way in this region. On a photograph by Max Wolf, of the region near ξ Cygni, there is a remarkable black hole and some smaller ones.

The question naturally suggests itself, what is the real nature of these curious black spots? Some astronomers have suggested that they are due to masses of cooled down, or partially cooled down, nebulous matter which absorbs the light of stars behind them. The term "hole," which I have used in the present paper implies that my own view is that they are really holes or openings through the regions of stars or nebulous matter, and in this view of the matter I am supported by the opinion of several astronomers, as some of the extracts quoted above will show. Photographs of the great "Coal Sack" near the Southern Cross prove conclusively, I think, that the darkness of this remarkable spot is due to a real paucity of stars compared with the richness of the surrounding regions, and probably the same thing is true of the other dark spots in the Milky Way. We have really no evidence of the existence of dark bodies in space. Professor Newcomb thinks that there is probably little or no extinction due to dark bodies, and he says, "We may say with certainty that dark stars are not so numerous as to cut off any important part of the light from the stars of the Milky Way, because, if they did, the latter would not be so clearly seen as it is. Since we have reason to believe that the Milky Way comprises the more distant stars of our system, we may feel fairly confident that not much light can be cut off by dark



The Milky Way round θ Ophiuchi.

(Photographed by Prof. E. E. Barnard.)

bodies from the most distant regions to which our telescopes can penetrate. Up to this distance, we see the stars just as they are."* The companions of some of the Algol variables are usually spoken of as "dark bodies," but I have shown elsewhere that we have no reason to think that they are really dark. The companion of Algol, for example, may be a star of the 5th magnitude—a comparatively bright star—and yet be quite invisible to us, as neither the telescope nor spectroscope would show any trace of its existence. The little evidence we have tends to show that the satellite of Algol is *not* a dark body. The idea of "dark bodies" and "dark stars" seems to have been based on the existence of this eclipsing satellite; but it has been recently found that a difference of brightness of two magnitudes between the components of a spectroscopic binary star—like Algol—would be quite sufficient to obliterate the spectrum of the fainter star, the spectroscope merely showing the spectrum of the brighter component. Dark bodies *may* exist in space, and probably do, but as yet we have no positive evidence of their existence. The "holes in the Heavens" are, I think, real, and "dark companions" of Algol variables have probably no existence except in the imagination of some astronomical writers.

It has been stated by several writers that the existence of these "holes" indicates that the Milky Way has a small extension in the line of sight; or, in other words, that it forms a comparatively thin stratum of stars. But Professor Seeliger has shown that, according to the Law of Probabilities, if the number of stars be the same in both cases, the probability against the occurrence of these holes is just *the same* whether the extension of the Milky Way in the line of sight be great or small.‡ We cannot, therefore, come to any conclusion as to the actual thickness of the Milky Way from the appearance of these dark spots. It may have a great extension in the line of sight, or it may be comparatively thin in that direction. The cause of these "holes" must probably be looked for in the influence of some "clustering power," as Sir William Herschel termed it, which tends to draw the stars away from certain spots and accumulate them in others. The existence of globular and other clusters close to dark and comparatively starless spots seems very suggestive in this connection. If these dark spots were due to intervening dark bodies, there seems to be no reason why we should find them so often close to rich regions.

* *Harper's Magazine*, October, 1904.
† *Astrophysical Journal*, Vol. 12, page 377.

Eels and Electric Light.

It appears tolerably certain that some species of eels migrate into the sea to spawn, and that the spawn hatches in the sea while the young undergo their transformations near sea shores. A belief, which is more doubtful of proof, is that the conger-eel does a good deal of damage to the coast fishing industry, and that this animal has so great a dislike to light that it will not migrate to the open sea when the moon is at the full. An experiment which will resolve some of these doubtful questions is to be made under the auspices of the Biological Society of Copenhagen. In the strait known as the "Little Belt," electric lamps are to be fixed at the bottom of the channel in order to deter the congers from making their way out to the open sea. The result of the experiment will be watched with much attention, both as regards the distribution of the congers and the effect on the shoals of food fishes.

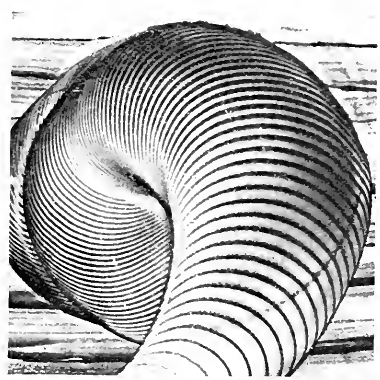
Royal Society.

Ladies' Conversazione.

THE second soirée of the Royal Society, that to which it is customary to invite ladies, was held at Burlington House towards the end of last month, and attracted a large and representative gathering. Some of the exhibits shown in May were repeated, but notwithstanding this there was a goodly number of fresh ones possessing intrinsic interest of which mention may be made here.

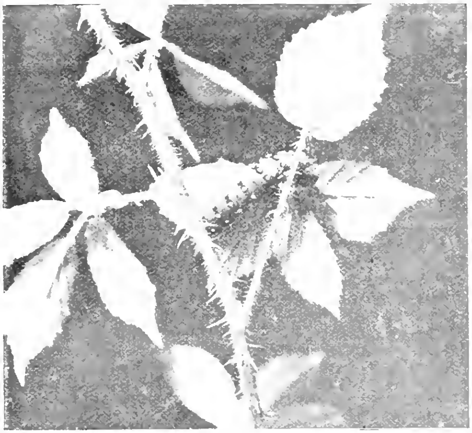
Voice figure—landscape pattern.

The pretty series of voice figures exhibited by Mrs. Watts-Hughes, with the able co-operation of Mr. Richard Kerr, F.R.A.S., were of singular interest. They were entirely produced by the vibrations of notes sung into a tube communicating with a cup-shaped



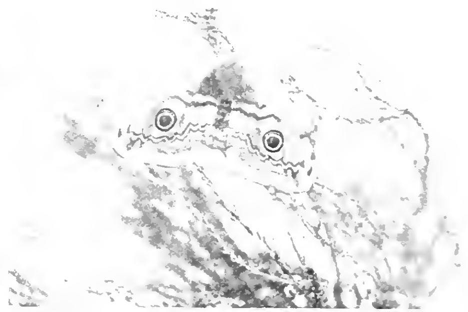
Voice figure—convoluted pattern.

vessel, a piece of india-rubber being tightly stretched over the top of the vessel; on this latter there rested a piece of paper covered with moist water-colour. As the sound waves impinged upon the under-side of the membrane a variety of devices arranged themselves without any kind of manipulation. Outline forms in natural colour resembling daisies, pansies, ferns, and trees, as well as geometric patterns, were produced, some as the result of high notes, others of low notes. Certain patterns required the notes to be softly sung, while others were the outcome of powerfully-rendered

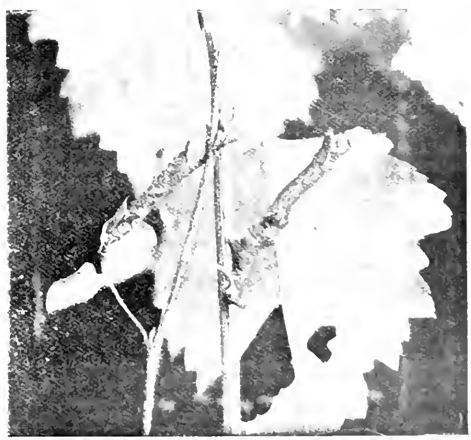


and sustained notes. A piece of glass, with spread moist water-colour, placed on the vibrating film, showed, when raised, patterns similar to the concentric rings of timber growth. On giving a spiral motion to the glass or to the vessel, simultaneously with the singing of the note, a series of waves in cornucopia fashion may be made to extend over the surface, producing a beautiful object for lantern displays.

One of the most attractive exhibits was that of Mr. F. Enock, who, by means of natural colour lantern slides, showed and described the adaptability of lepidopterous insects to the changeful circumstances of their environment—Nature's own way of protecting insect life. The illustrations which we give fail to convey an adequate idea of the manifold colours thrown upon the screen referring to instances of protective resemblance. No more fascinating study we may well imagine could engage the naturalist's attention than this method of reflecting the doings of the insect world. We see in the first reproduction the larva of the Emperor Moth (*S. carpini*) ensconced and at rest on bramble; the leaves of the plant match the larval body colour, while the



spiny tubercles successfully strive to imitate the thorns. The female moth of the same species is seen at rest on heather, after ovipositing on the tips of the stems. The eggs are so cleverly arranged as to resemble the buds of the plant, being of the same size, as well as quadrangular in plan. Yet another example is that of the Orange Tip butterfly, which rests with wings closed



amongst the flowers of the umbelliferous plant, Fools' Parsley. When "working" the flower, the insect's wings are wide open, but let a cloud or shadow pass over, and they immediately close together as depicted in our photograph (near cross), the protective green colouration and irregular mottlings effectually masking the living butterfly and rendering it almost indistinguishable from its floral surroundings. The rolled-up leaf, adjacent to the birch leaf in the fourth illustration of this series, is the chosen home of a beetle. Its twig-like companion is none other than the larva of a Thorn Moth (*S. illunaria*).

The advantages of the three-colour process of photography were also apparent in Mr. W. Saville-Kent's brightly illuminated transparencies illustrating the fauna of the Polynesian coral reefs, especially those referring to the gaily coloured fishes which make the recesses of such coral growths their habitation. A striking series of specimens of fossil plants from the English coal measures, with illustrative microscopical slides, was on view, a display with which Miss M. Benson, Miss W. Brenchley, Prof. F. Oliver, F.R.S., and others were identified. A newly discovered petrified stem from Shore, Lancashire, indicated the structure to be of a type hitherto unknown. Some models of branching stems, which furnished accurate reconstructions of petrifications, were, too, of great interest.

Sir William Crookes conducted an elaborate series of experiments in illustration of some properties of the diamond. The squeezing of a natural crystal into steel by means of hydraulic pressure in order to demonstrate the hardness of diamond was beautifully shown by the optical projection upon a screen of the slow transit of the object into the metal until it became lost to sight. In the electric arc the precious gem was seen burning up and turning into graphite. The facile manner in which it will plane a glass surface was shown by a slide of curly glass shavings. One diamond thrown upon the screen had been obtained from the remarkable Canyon Diablo meteorite, of Arizona. Prof. W. Gowland also showed under the microscope diamonds found in this meteorite. Some will, perhaps, remember that it was this particular meteoric mass that secured the ubiquitous attentions of American speculators a year or so ago, when the inevitable company was formed, with the idea—of course a futile one, of exploiting it for diamonds.

From the Royal Institution laboratory came Sir James Dewar's new charcoal calorimeter and thermoscope. In this instrument charcoal when utilised at the temperature of liquid hydrogen and in conjunction with certain gases exhibits great sensibility to heat and light radiation, and can be used in calorimetry. There were also spectrum tubes containing helium, neon, krypton, and xenon, these gases having been separated by the charcoal method. A demonstration of the scientific uses of liquid air formed a popular feature. The fine piece of photo-micrographic apparatus for ultra-violet light, designed by Dr. Kohler, and ably explained by Mr. Max Poser, of the firm of Zeiss, was considered by physicists present to be a splendid instrumental achievement. It was suitably shown for the first time in this country at the soirée.

In archæology, Dr. Flinders Petrie contributed examples of black incised pottery from Egypt, of date 2000 B.C., as well as photographs from Sinai taken during the progress of his recent exploring expedition in that quarter.

Lastly, we should not omit to mention a set of diagrams sent by Prof. Karl Pearson, F.R.S., and Mr. J. Blakeman, illustrative of Lord Rayleigh's solution of the "problem of the Random Walk," a mathematical excursion, decidedly perplexing, however, to the layman. For information on the subject, our readers should refer to *Nature*, Vol. 72.

Some Rudimentary Structures.

By R. LYDEKKER.

ON a first visit to an English assize court, the stranger, if he occupy a sufficiently elevated position, will scarcely fail to notice the presence of a small black patch on the top of the full-bottomed wig of the presiding judge, and, if he be of an inquiring disposition, he will want to know the reason for this apparently useless feature. Reference to any treatise on the history of costume will inform him that this apparently unmeaning patch is the last remnant or survival of the coif, or black cap, with pendent lappets, originally worn by the "sergeants learned in the law," from among which body the judges were formerly selected. The patch affords therefore an excellent example of a structure which, although now perfectly useless, once had a definite and more or less important function. In other words, it exactly corresponds to what are commonly called rudimentary structures in the animal kingdom. I say commonly called rudimentary structures, purposely, because in scientific circles they are now more generally designated vestigiary structures; and, strictly speaking, quite rightly so, for a rudiment properly means the commencement of any thing, whereas these are the last vestiges of the structures they represent. They are decadent, and not incipient. Nevertheless, since the term vestigiary is somewhat cumbrous, and by no means so well known as rudimentary, I shall take leave to use the latter, especially as it is employed by Darwin, in this sense, in the "Origin of Species."

Rudimentary, or more or less completely functionless organs are extremely common in both the animal and the vegetable kingdoms; and they can have but one meaning. That is to say, they afford practically decisive and irrefutable evidence in the minds of all unprejudiced persons of the truth of the doctrine of evolution. For it is absolutely inconceivable that such useless structures, which in many instances can be traced by regular gradations into those which were evidently functional, could have been created in their present condition. Indeed, if we had no other evidence in favour of the evolution of animal forms from pre-existing types, it is perhaps not too much to say that the evidence of these rudimentary structures would alone be sufficient to prove the truth of that great doctrine.

Since rudimentary structures are so common in nature we suffer from an *embarras du richesses* in attempting to select instances to form the subject of an article of the length favoured by the Editor of this journal; and the reader must consequently be not surprised if he finds no mention of many cases of this kind with which he may be more or less familiar. As a matter of fact, cases of this nature to which the present writer has had occasion to devote special attention form the chief of those noticed in this article.

Among the larger animals of the present day, no species is more highly specialised than the horse (and its immediate relatives), and it would consequently be only reasonable to expect that in the course of its evolutionary progress this creature should have found certain elements in its organisation superfluous, and should therefore have done its best to discard them. This expectation is fully realised by the actual state of the case; and it may be regarded as a fortunate circumstance that the total elimination of such superfluous structures appears to be an exceedingly difficult process, so that their rudiments, or vestiges, are frequently left to tell the tale of their gradual degeneration.

As regards some of the rudimentary organs occurring in the horse, one of the most interesting is the remnant in the skull of the Eastern breeds, of the cavity in front of the eye, which, in the extinct three-toed hipparions probably contained a gland similar to the larmier, or face-gland, of deer and many antelopes. Fuller reference to this rudimentary gland-cavity, which is often very faintly marked, will be found in "KNOWLEDGE & SCIENTIFIC NEWS" for August, 1904.

At first sight there may seem to be little, if any, connection between this last vestige of the hipparion's face-gland, and those curious warty structures on the inner side of the limbs of the horse, which are commonly known as callosities, or chestnuts (Fig. 1). It appears to be a very general belief that these structures

Fig. 1.—The Left Fore and Hind Limbs of a Horse, to show the Callosities, or "Chestnuts."

are for the purpose of serving as cushions, or pads, to ease the pressure on the limbs when the animal is lying down. This, however, is obviously out of the question; and it is quite certain that the callosities are now useless remnants of structures that were once functional. The question is, what those structures were. One theory is that they were foot-pads, or cushions, comparable to those on the foot of a dog or a cat; and in order to support this hypothesis, it has been stated that they are situated much lower down in the fœtus than in the adult, so as to be situated on what corresponds to the foot of other mammals. This, however, is not the case, as is demonstrated by specimens exhibited in the Natural History Museum.

A much more probable theory is that these callosities represent scent-glands, comparable to those on the limbs of deer. Strong support to this is afforded by the fact (as I am informed) that the secretion which exudes from these callosities when cut will cause a horse to follow any substance anointed therewith; and also by the poacher's practice of carrying a fragment of one of them to keep his dog quiet. That a rudimentary foot-pad would have any effect of this kind is, of course, quite out of the question, although nothing is more likely than that such emanations should proceed from a decadent foot-gland.

In regard to the connection between the rudimentary face-gland of certain horses, and the callosities, it may be noted that both face-glands and foot-glands appear to be for the purpose of aiding animals in finding the whereabouts of their fellows; the leg or foot glands leaving a scent on the grass or jungle through which they pass. If, however, animals live on open plains, as is the case with horses and zebras, where they can see one another at long distances, such aids may be quite unnecessary. We know that the horse and its kindred have lost the facial scent-glands of their ancestors, and what is more likely than that they should at the same time have discarded their leg-glands, of which the callosities are the last remnants?

That the horse does retain vestiges of the foot-pads of its ancestors, who applied a portion of the sole of their foot, instead of only the nail (hoof) of the middle toe, to the ground, appears, however, to be undoubted. At the hinder basal extremity of the second joint of the pastern is a curious little horny spur (very conspicuous in the fœtus), known to veterinarians as the ergot; and this ergot seems to represent the central pad of the foot of the tapir. As this part of the foot of the horse does not touch the ground, the pad is of no functional importance, and has consequently degenerated to this curious little horny spur.

Other rudimentary organs in the horse are the splint-bones lying on either side of the upper end of the fore and hind cannon-bones, and representing the functional metacarpal and metatarsal bones, and sometimes even the lateral toes of the hipparion. In domesticated horses not only are these bones useless, but they are actually harmful, producing the disease called splint. How this accords with the theory that the horse has been specially evolved for the use of man, may be left to those who hold that theory to explain. Even this does not exhaust the list of rudimentary structures in the horse. In the "knee," or carpus, of the hipparion exists a bone known as the trapezium, which supports one of the aforesaid metacarpal bones of the lateral toes. In the horse this bone is functionless and very minute, and is present only in about fifty out of every hundred individuals; so that it is evidently about to follow in the wake of the lost lateral toes.

In the horse only certain elements of the limbs have become rudimentary, in order to permit the greater development of other elements of this part of the skeleton. In some groups of animals on the other hand, one or both pairs of limbs are, in many instances at any rate, completely wanting; and had it not been that they are occasionally represented by minute vestiges, we should have had no direct evidence that they ever existed in the group. As it is, we are absolutely certain (if evolution be the true explanation of the resemblance of animals to one another) that snakes and whales are descended from creatures with four limbs.

In regard to snakes, most members of the group, show no traces of limbs, either externally or internally; but in the family groups which include the boa-constrictors and pythons (the *Boidæ* of naturalists) it fortunately happens that in many species, at any rate, minute vestiges of the hind-limbs are retained, as if for the very purpose of telling us the story of their ancestry, for it is quite certain that in most instances at all events, these rudiments are absolutely useless.

The second illustration to this article shows the external vestiges of the hind-limbs in an African python (*Python seba*) over twenty feet in length. These vestiges take the form of a pair of horny spurs, or claws, about three-quarters of an inch in length, and situated on the under surface of the body at the commencement of the tail. In the specimen figured, the skin has been slit along the middle line of the belly, so that the two claws are separated from one another by the width of the skin of the back and flanks, whereas in nature they would be comparatively close together. Each claw in this specimen was supported on a bony core, corresponding to the terminal bone of one of the toes of a lizard's foot, while embedded in the flesh beneath was a much stouter bone, probably representing the femur, or thigh-bone, and also a minute nodule, which may be the last remnant of the pelvis. It must not, however, be supposed that all pythons exhibit these vestiges as distinctly as in this specimen. On the contrary, in the skin of a Malay python (*P. molurus*) of five-and-twenty feet in length, which I recently ex-

Fig. 2.—Part of the Skin of the Tail of a Python, showing the Horny Spurs representing the Hind Limbs.

amined, the external rudiments of the limbs were minute lobes, scarcely larger than the head of a big pin. Somewhat similar vestiges of the hind-limbs are retained in the small burrowing tropical snakes of the family *Typhlopidæ*, as well as in the members of a nearly allied group; but in no snakes have any traces of the front-limbs been detected.

These vestiges, then, afford decisive evidence that snakes are descended from reptiles with functional hind-limbs, from which it may also be inferred that their early ancestors were four-limbed; the front limbs, as in the case of certain snake-like lizards, being the first to disappear. The further inference that those snakes which retain rudimentary hind-limbs are the most archaic members of their kind, has been recently confirmed by the discovery that pythons and boa-constrictors display certain primitive features in other parts of their anatomy.

Space admits of but very brief allusion to the case of whales. As everyone knows, all the members of the order Cetacea, inclusive of whales, dolphins, porpoises, &c., have but a single pair of limbs, the front ones, which are modified into paddles for swimming. It is, however, far less well known that deep down among the muscles of the body of the Greenland right-whale and its immediate relatives are embedded certain small and useless bones which represent those of the pelvis, and part of the hind-limbs of less specialised mammals. These rudimentary bones are alone sufficient to demonstrate the descent of whales and dolphins from four-limbed ancestors; and when taken in connection with the fact that cetaceans are air-breathing (as opposed to gill-breathing) creatures, lead to the conclusion that their ultimate ancestors were terrestrial. Curiously enough, it is the most specialised whales (that is to say, the true, or whale-bone whales) that alone retain rudiments of the hind-limb itself; these vestiges in the toothed whales, such as the sperm-whale and dolphins, being restricted to the bones of the pelvis. In this respect, then, cetaceans are unlike snakes, in which, as we have seen, it is the most primitive forms that alone retain vestiges of limbs.

Turning to the subject of the third illustration, we have an exceedingly interesting example of a more or less completely rudimentary structure, in the so-called worm-like appendage, or *appendix vermiformis*, of the human blind gut, or *cæcum*. In this connection it may be well to mention incidentally that the disease to which this organ is so frequently subject, derives its name of *appendicitis* from the organ itself, and its al-

Fig. 3.—The Vermiform Appendix, and the adjacent parts of the Human Alimentary Canal.

ternative title of *typhlitis*, from the Greek τυφλός, blind, in reference to the blind gut of which the appendix forms the termination.

In a great number of mammals, both herbivorous and carnivorous, there exists at the angle formed by the junction of the small intestine or ileum with the large intestine or colon, a large blind pouch or diverticulum, which probably aids in the digestion of food by preventing its too rapid discharge. The cæcum, as it is called, is remarkably well developed in the horse and the dog, in the latter of which it is coiled in a spiral manner. In the human subject, on the other hand, the cæcum proper is very short, but is prolonged by the aforesaid vermiform appendage, which is usually from four to five inches in length, with a calibre of only about one-third of an inch. This appendage corresponds to the coiled cæcum of the dog, of which it is obviously an aborted rudiment. As many of us know by sad experience, it is only too likely to become choked by closely packed, partially digested, or undigested food; and the opinion has been very generally held that it is an altogether superfluous and useless organ whose complete elimination would be an unmixed advantage to the human race. For instance, on page 282, of "The Student's Darwin," by Dr. Aveling, we find the following statement in reference to the vermiform appendage:—

"It is to man useless. Nay, it is worse than useless. It is at times a special death-dealer. Small, hard bodies, as the seeds of fruits, entering the appendix, cause inflammation and death. In the animals lower than man, this organ is of great size and functional importance. That of the orang-utan is long and convoluted."

On the other hand, an eminent surgeon has recently expressed the opinion that the appendix may still have a certain amount of digestive function. To controvert such an opinion would obviously be presumption on my part; but whether or no it still retains any active function, the structure in question is evidently a pronounced example of a rudimentary organ, and one which, by the way, leads to the conclusion that man is descended from an animal furnished with a long and complex cæcum. Incidentally, it may be mentioned that, in addition to man, the only animal possessing a vermiform appendix is the Australian wombat, a member of the marsupial order. Truly a remarkable instance of parallelism in retrograde development!

With Figure 4, I come to the last section of my subject, and I must confess that I am by no means certain that it properly belongs to my subject at all. The object represented on the left side of the photograph in question is the tip of the tail of a lion, showing the presence of a small horny prickle or spur (*s*) buried among the terminal tuft of hair. In the natural condition, it should be mentioned, the spur was completely concealed by the long hair, and it was only by cutting away a portion of the latter that it was made visible. What may be the history or use (if it has a use) of this spur, no one seems to know, and I have no intention of hazarding a guess. The old story, that it was for the purpose of enabling the lion to goad itself into a fury when about to attack, is obviously an absurdity, more especially as it seems that the spur is

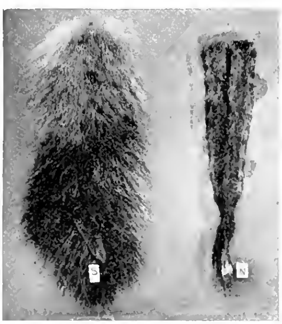


Fig. 4—Tip of Tail of Lion (on the left), and of Nail-tailed Wallaby (on the right), showing Horny Spur and Nail.

developed in only a comparatively small percentage of lions. If any of my readers can solve this problem, they will be the means of removing one blank from future zoological text-books. I fear it will not help them much to learn that one species of kangaroo, or rather wallaby, possesses a very similar caudal appendage, which is, however, of a somewhat more nail-like form, as shown at *N*, on the right side of Figure 4.

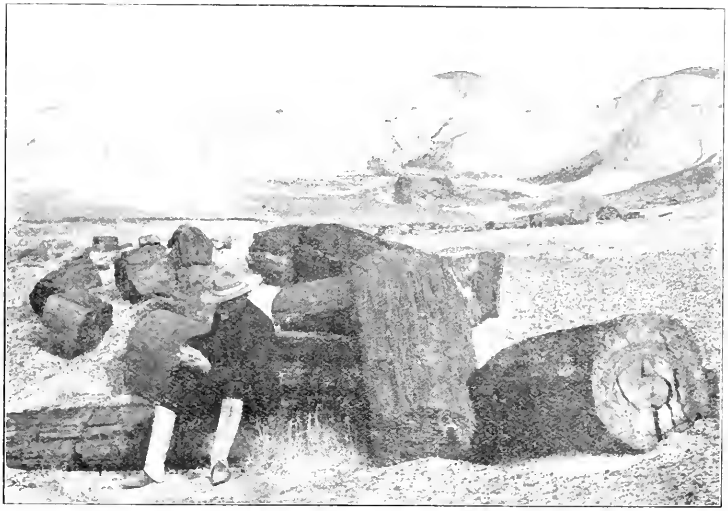
It may be added that all the figures in this article have been reproduced from photographs of specimens exhibited in the Natural History Branch of the British Museum at South Kensington.

The Petrified Forest of Arizona.

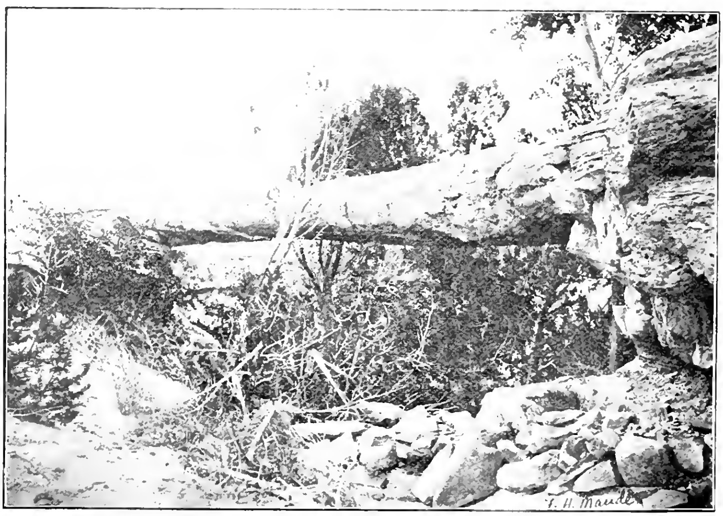
The petrified forest of Arizona is seldom visited because of its inaccessibility to the ordinary traveller, though it is but 2,500 miles from New York. It lies in a district possessing archæologic attractions as well as geologic problems, for the village of Adamana, in Apache country, which is the only human habitation within easy reach of the forest, is the centre of a neighbourhood full of Indian ruins. The most interesting of these ruins are those of the cliff dwellers who made their homes in the minor bluffs which border the canyons and plateau-like spaces of the petrified forest. The extreme height of these cliffs does not exceed a hundred and fifty feet, but they are identified with the forgotten Indian tribes of the Hopi and Zuni; and an ancient fort together with various rock inscriptions and other relics and ruins give colour to the legend that the Aztecs once inhabited this region. The only dwellers now in this great intersected plateau 5,000 feet above sea-level are the historic Navajo Indians. Such are the situations and the surroundings of the petrified forest of Arizona, which is divided into three sections marked by the same general characteristics. Fragments of lava, beds of basalt, and the peculiar pitch of the upheaved strata point to a period of volcanic activity. The first casual opinion that is formed in surveying the petrified tree trunks is that an ancient forest flourished on the spot; that it may have become submerged and petrified under the saline action of some encroaching inland sea, and that centuries after the great winds and sandstorms of the high plateau swept off the covering of sand and silt from the tree trunks. This theory, plausible as it may at first sight appear, must, however, give place to the alternative theory that almost the whole of the vast and remarkable deposit dropped from a neighbouring plateau, where it was for long embedded, and whence it was eventually washed into the valley seven hundred feet below.

Quite apart from the scientific interest of the Adamana forest is its wonderful picturesqueness and beauty. Each step reveals deposits of topaz, agate, cornelian, amethyst, onyx, and chalcedony in such an advanced stage of mineralisation as almost to give them place among gems and precious stones. Chips and segments of gem-like chalcedony, which once were portions of living trees, cover the earth beneath one's feet, and vari-coloured columns (hard as flint and shaded like the rainbow) are huddled around, still bearing the familiar outline of their original forest state. The colours at the sections where the trunks have broken across are always the brightest, and fully suggest the radiant development that can be secured by the lapidary.

In the conglomerate stratum of the plateau are still embedded thousands of tree trunks, some projecting and showing round the bark an encrustation of sandstone, exactly similar to that found on the surface of the trees in the petrified sections at the lower level. Firs and oaks were the main constituents of the once living forest, yet minute search among the deposit, which covers an area of more than eight square miles, has failed to reveal any vestige of acorn or cone. This circumstance, together with the fact that no branches have been found, that none of the trees are upstanding, and that several of the short stumps have the root end



Petrified Tree trunks near Adamana.



Natural bridge formed by a Petrified Tree trunk in the Arizona Forest.

uppermost, is accepted as strong evidence that the forest did not grow on its present site. There is the further argument that the number of trunks found huddled together all over the area are greatly in excess of the number of trees that could have grown to a vigorous maturity on such a limited surface. That the action of silicification set in after the destruction of the forest is a matter of universal acceptance; yet a very interesting theory could be developed on this point from the existence round the base of the trees of a thick sandstone coating which lessens on, or entirely disappears from, the bark encasing the topmost sections.

In the third and largest section of the forest, thirteen miles from Adamana, there are several hundred whole trunks partly embedded in the earth, some of which exceed one hundred and fifty feet in length. The colours here are very striking, and the crystal deposits of considerable frequency. The second or middle forest is the smallest of the three, but in its two thousand acres are many fine specimens of wood agate, those named the Twin Sisters being the most widely known.

The distance between Adamana and the first forest is only six miles, and on the road between there are prehistoric ruins made out of logs of this fossil wood, which also served for the construction of implements found in Pueblos hundreds of miles away in the desert. The majority of the trees in all parts of the dead forest are broken off in sections, ranging from two to twenty feet, but the first forest, which has a higher altitude, possesses one of the most remarkable exceptions, which unquestionably grew on the spot where it now lies. It measures one hundred and eleven feet in length, with a base diameter of four feet four inches, graduating to eighteen inches at the other end, and in its prostrate position it spans a fifty feet wide canyon, making a unique natural bridge over the intermittent river, whose bed is twenty feet from the canyon's edge.

An Interesting New Asteroid.

ON February 22, 1906, a new asteroid was detected by Max Wolf at Heidelberg, which was found to have a remarkably small rate of retrogradation, about 30 secs. daily. The provisional designation of this body is TG. Later Dr. Berberich deduced circular elements for the asteroid, which indicated that its mean distance was 5.05, almost identical with that of Jupiter, and from more recent observations, April 22, combined with those of February 22 and March 23, has computed elliptic elements. These show a mean distance a little greater than Jupiter, and aphelion distance about one unit beyond the orbit of Jupiter. A. C. D. Crommelin draws attention to the fact that the family of asteroids now extends from distance 1.1 (perihelion of Eros) to distance 6 (aphelion of TG), and in consequence the investigation of the perturbations of TG by Jupiter should prove very interesting on account of the equality of their mean motions. In the present positions of the orbits no very close approach occurs. (*Observatory*, June, 1906.)

"THE value of glass may far exceed that of gold," says *Amateur Work* (Boston). "A contemporary draws attention to its enormously increased value when made up into microscope objectives. The front lens of a micro-objective, costing 5 dollars, does not weigh more than about 0.0018 gram, which weight of gold is worth about one cent, and so the value of a kilogram of such lenses would be about 3,000,000 dollars. The cost of the raw material for making this weight of glass is from 5 cents, and thus, when worked up into the shape of a lens, the glass has been increased in value about fifty million times. Such disparity between the cost of the raw material and the manufactured article is probably a record in industrial technics."

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Efficiency of Shutters.—Although shutters are now very commonly employed, there are many false ideas held with regard to them. It has been stated so frequently that it seems to be commonly accepted as a fact, that focal-plane shutters give an efficiency of one hundred per cent. Before making any precise statements, it is necessary to make clear what is meant by the word *efficiency*. If it is defined as the ratio between the actual period of the exposure and the time that would be necessary to produce the same light effect if the shutter were removed, that is, if the opening and closing took no time at all, then the focal-plane shutter is the least efficient of any pattern, for the time taken for the narrow slit to pass across the front of the plate is always considerable, because of the great distance it has to travel. But if efficiency is taken as applying, not to the whole plate, but to each point of it separately, so giving the focal-plane shutter all possible advantage, still its efficiency is not, and never can be, one hundred per cent. Considering shutters of all classes so far as I know them, the general statement, that in giving their minimum exposures the efficiency tends towards fifty per cent. may be accepted as correct. That is, the actual period is about twice as long as would give the same light effect if the uncovering and re-covering of the plate or lens took no time at all. The application of this principle to the focal-plane shutter is not generally appreciated. By reason of the exigencies of construction the slotted blind must be an appreciable distance in front of the sensitive surface, and the aperture of the lens must be considerable. It therefore follows that each edge of the opening gives a penumbra, and that the exposure of every point of the plate begins gradually, increases to a maximum, and then diminishes to zero, as in all other shutters. There are some shutters that give an efficiency of less than fifty per cent., but this is because either of faulty construction or the endeavour to get an exposure that is shorter than the apparatus will properly give. The advantage of the focal-plane shutter is not in its greater efficiency when giving its minimum exposure, but that its shortest exposure (having regard to only one point of the plate) is, say, about a tenth of the shortest exposure given by a lens-shutter, so that in giving the same exposure with both of, say, the one-hundredth of a second, the lens-shutter is working at its quickest and with its minimum efficiency, while the focal-plane shutter is giving ten times its shortest exposure with a corresponding gain in efficiency. On the other hand, a diaphragm shutter that opens from the centre will permit of the use of a larger opening in the lens for the same defining power and depth of definition, because the greater part of the exposure is given with smaller apertures than the full, by reason of the shutter acting the part of an expanding and contracting diaphragm. There are many other details that might be referred to in this connection, for the matter is much more complex than it is generally considered to be.

What is the One-hundredth of a Second?—It is easy to talk glibly of such an exposure as this, and to engrave the fraction on the shutter, but the definition of it is not so simple. Of course, such a period of time simple enough in itself, but, as applied to photographic exposures, it may mean three distinct things, and which of the three it means I have never been informed when buying a shutter. It may signify (1) the whole duration of the exposure; (2) the effective duration of the exposure; or (3) the equivalent exposure. With all shutters, the exposure begins and ends gradually, and the "effective duration" neglects the time taken up at the beginning and end of the exposure when the light action is so small as to be negligible. The "equivalent exposure" is the duration of an exposure that would give the same light-action if the opening and closing required no time at all. If the photographer has a satisfactory amount of exposure with an aperture of $f/16$, and one twenty-fifth of a second, and he wants to shorten the duration of the exposure and still maintain the same amount of light-action by increasing the aperture of $f/8$ and the shutter speed to one-hundredth of a second, then he wants equivalent exposures marked on his shutter, and this, I believe, is what most people do want. But if he calculates from the rate of a moving object and the permissible blur, the maximum duration of exposure that will conform to his conditions, then he wants to know the effective duration of the exposures. I believe that such calculations are very rarely made in practical work, even in those cases where they would be simple and advantageous. The whole duration of the exposure is of use only in a secondary sense, or under very exceptional experimental conditions.

A New Shutter.—It is risky to call anything new. But I believe the adjective is strictly applicable to a shutter that will shortly be put on the market by Messrs. Taylor, Taylor and Hobson. It embodies several new details, the consideration of which will be found in a communication made by Mr. William Taylor to the Royal Photographic Society, and published eighteen months ago in their Journal. The shutter is diaphragmatic, and acts the part of a diaphragm as well as a shutter by means of a simple contrivance that limits the movement of the leaves, so that the maximum opening is the aperture desired. A separate iris diaphragm being unnecessary, the space that has to be left between the lens components for the working of the shutter is practically the same as is required for the usual diaphragm alone. The shutter has four leaves, arranged like an iris diaphragm, but the edge of each is so cut that the opening made is always eight-sided, a much nearer approach to a circle than is often obtained in such apparatus. The opening and closing is done always at the same rate, the varying periods of exposure being obtained by stopping the movement for the desired time when the opening is at its maximum, and not by slowing the moving parts, so that the longer the exposure the greater the efficiency. For the most usual exposures, the twenty-fifth of a second and longer, the efficiency is, I believe, from over 90 to about 97 per cent., and the difference between such figures and a hundred is negligible in general work. The shorter exposures are arranged to give the due proportion of light effect; they are definitely made to be the equivalent exposures, as explained above. The example I have gives exposures from one second to the one-hundredth of a second. The pneumatic break is exceedingly compact and efficient, and all the mechanism is enclosed so that it is protected as far as possible from dust. I have referred rather in detail to this particular apparatus because it seems to me a distinct advance in shutter mechanism, and, indeed, to leave very little, if anything, to be desired as a shutter for general use.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Constant Deviation Prisms for Radial Velocity Determinations.

An interesting property of the constant deviation prism was demonstrated recently by T. H. Blakesley, showing that by employing two prisms of the same angle, but inverted with respect to their bases, there would be produced two spectra of opposite sense. When a star was brought into the field the two spectra would, of course, have their colours in opposite directions, and the adjustment would be such as to make any particular line coincident in the two spectra if the light source were at rest; for a body in motion the line would be split up into two moving in opposite directions in the field of view. Measurements of the distance apart of these lines will give the necessary data for calculating the radial velocity of the star.

Work at Greenwich Observatory, May, 1905—May, 1906.

In his report presented to the Board of Visitors on May 30 the Astronomer-Royal briefly summarises the various classes of investigation which have occupied the staff during the past year.

Transit Instrument.—This has been repaired, and owing to some difficulty connected with the repolishing, the instrument was out of use for about two months. During the rest of the year 6,335 transits were observed, and 5,531 observations with the circle. Two hundred and fifty-seven reflection observations of stars were made, and numerous determinations of level and collimation error. The transits are completely reduced to 1905, December 31, and apparent R.A. is formed to 1906, May 6. The circle observations are completely reduced to 1905, December 31, and as far as apparent N.P.D. to 1906, May 6. The new working catalogue of stars of magnitude 9.0 and brighter, between the limits of $+24°$ to $+32°$ of N. Declination, forming reference stars for the Oxford Astrographic Zone, has been completed, and includes more than 12,000 stars, the places of which have been brought up to 1910. A new determination of the pivot errors was made in November, showing them to be insensible.

Altazimuth.—Various adjustments have been made of the object-glass mounting, and the instrument mainly used as a reversible transit. Observations of the sun, moon, planets, and fundamental stars have been made throughout the year.

28-Inch Refractor.—This has been used for micrometric measures of double stars, diameters of Jupiter and its satellites.

Thompson Equatorial.—With the *30-inch reflector* photographs of Jupiter's satellites VI. and VII., minor planets, Nova Aquilæ, Comet a (1905), and various nebulæ were obtained during the year. With the *26-inch refractor* 72 photographs of Neptune and its satellite were taken on 28 nights, and are now being measured.

Spectroscope.—A number of experimental spectra of sun-spots have been photographed in the 3rd order spectrum.

Astrographic Equatorial.—One hundred and sixty-four photographs have been taken on 60 nights. Various remeasures of the catalogue plates have been made in the zones 80° to the Pole. A table is given showing the numbers of separate stars measured for zones of 5° in the section allotted to Greenwich, from which it appears that considerably more than six times the number of stars will be included in the resulting catalogue than are contained in the *Bonn Durchmusterung.* Reproductions of enlarged prints of the chart plates have been made as far as possible.

Photoheliograph.—Photographs of the sun were obtained on 210 days. The Thompson telescope was taken to Sfax for the total solar eclipse, and excellent photographs of the solar surroundings obtained. By the co-operation of other observatories photographs were obtained for measurement of spots on faculæ on 364 days during 1905, the missing day being 1905, January 1.

Magnetic Observations.—The principal results for 1905 are as follows :—

Mean Declination = 16° 9'·9 West.
Mean Horizontal Force = (4·0173 (British Units.) (1·8523 (Metric Units)
Mean Dip (with 3-in. needles) = 66° 55' 55".

In 1905 there were no days of great magnetic disturbance, and only 12 of lesser disturbance.

Personal.—During the year Mr. F. W. Dyson, the chief assistant, was appointed Astronomer-Royal for Scotland, and the vacancy was filled by the appointment of Mr. A. S. Eddington, B.A.

In concluding his report the Astronomer makes some strong remarks concerning the serious interference with the work of the observatory which is caused by the new power station of the London County Council, situated on the riverside, due north of the transit circle, and only about half a mile distant. The tremors caused by the engines are stated to be much more violent than would have been anticipated from experience of the engineering plants that have been carefully tested.

Stereoscopic Determination of Stellar Proper Motions.

Herr Dr. Max Wolf, Director of the Astrophysical Observatory at Heidelberg, has for some years past very successfully employed the stereoscope for detecting asteroids on photographic star charts taken at intervals, and he has recently extended this delicate method of comparison to the determination of proper motions of stars perpendicular to the line of sight. The process involves the operation of comparing, in an ordinary stereoscope, two photographs of the same portion of the sky taken at several years' interval.

In the case of plates of a well-known star submitted to the Paris Academy there is a distinctly visible alteration in the appearance of the star from its surroundings, although the two component photographs were obtained at an interval of only four years. Another comparison refers to a star of the ninth magnitude in Leo, whose proper motion now becomes known for the first time. The two plates for showing this were taken at an interval of fourteen years.

Not only is the detection of proper motion rendered much more easy by this method, but Dr. Wolf is of opinion that its magnitude can be determined more accurately than by the usual micrometric method.

As examples of other problems to which the stereoscopic method of comparison may with advantage be applied, mention is made of the examination of meteors, comets, the lunar mountains, and certain nebulæ (*Comptes Rendus*, 142, pp. 1007-8, May, 7, 1906.

Parallax of Nova Persei.

M. O. Bergstrand has recently endeavoured to determine the parallax of the Nova Persei from observations made at the observatory of Upsala in 1901 and 1902.

His result is

$$p = 0''\cdot03 \pm 0''\cdot01$$

Distribution of Radium in the Earth's Crust.

An important paper dealing with the results of an investigation of the mode of occurrence of radium in the earth's crust has been communicated to the Royal Society by the Hon. R. J. Strutt. He concludes that : (1) Radium can easily be detected in all igneous rocks. Granites, as a rule, contain most radium ; basic rocks the least. (2) This distribution of radium is sufficiently uniform to enable a fair estimate to be made of the total quantity in each mile of depth of the crust. (3) The result indicates that the crust cannot be much more than 45 miles deep, for otherwise the outflow of heat would be greater than that actually observed. The interior must consist of totally different material. This result agrees with Professor Milne's conclusion drawn from a study of the velocity of propagation of earthquake shocks through the interior. (4) The moon probably consists for the most part of rock, and, if so, its internal temperature must be far greater than that of the earth. This explains the great development of volcanoes on the moon. (5) Iron meteorites contain little, if any, radium. Stony ones contain about as much as the terrestrial rocks which they resemble.—(Proc. Roy. Soc., 77A, pp. 472-485, 1906.)

New Method for the Discovery of Asteroids.

An interesting method has recently been adopted by J. H. Metcalf for the photographic determination of asteroids. It may, perhaps, be best described as the inverse procedure to that adopted by Max Wolf at Heidelberg, where the star field is accurately followed by clockwork, and any asteroids present record themselves as short trails among the numerous minute points representing the stars. When the asteroids are in opposition they retrograde about 34" an hour, and thus in an instrument of large dimensions the trails must of necessity be somewhat faint ; therefore a limit is soon reached to the brightness of asteroids which will be detected by the trail. The author, therefore, calculates the mean velocity of the asteroids in the region it is proposed to examine. By inspection of the positions and daily motions given in the *Berliner Jahrbuch*, it is possible to get a close value of the extreme values for the motions of the asteroids already known in a certain region. The general direction of motion will be parallel to the elliptic. By means of a finding telescope with micrometer wire the camera is so adjusted that it can be moved at short intervals in the calculated direction ; at the end of the exposure all the stars in the field will be represented by short trails, while any asteroids which may be present will most probably be shown as points or only very short lines. Excellent photographic reproductions of asteroids found in this way are given, one of about the thirteenth magnitude. The author acknowledges the description of a somewhat similar method of photographing unknown objects which was published by E. E. Barnard in 1897.

Testing of Optical Surfaces.

M. G. Meslin describes a very interesting method of testing optical surfaces which is more widely applicable than the now well-known method of using Newton's rings and monochromatic light. By employing a grating instead of the parallel test plate a new series of interference phenomena are brought into play, and the most important factor from a practical standpoint is that these new bands are very distinct in ordinary white light, so that little special apparatus is needed. The grating is placed over the surface to be tested, either in contact or a few millimetres distant.

An interesting distinction of these grating interference bands from Newton's rings is that they are scarcely coloured, being almost achromatic when viewed at an incidence about 45° ; further, the diameters of the rings *diminish* when the incidence is increased, whereas Newton's rings *increase* in diameter under similar conditions. They may be rendered very brilliant by increasing the reflecting power of the surface to be tested, say, by silvering, and hence the method may be applied to the examination of metallic surfaces, and also of liquids, such as mercury. *Comptes Rendus*, 142, pp. 1,039-1,042, May 7, 1906.)

BOTANICAL.

By G. MASSEE.

Protective Adaptations in Plants.

SOME remarkable instances of protective adaptation have been described, and beautifully illustrated, by Sir William Thiselton-Dyer, in the *Annals of Botany*. The plants under consideration are natives of South Africa, and, growing in an arid region, had two problems to face : to reduce to a minimum the loss of water by transpiration, which was accomplished by assuming a spheroidal form, thus presenting a minimum of surface ; and, secondly, to secure as far as possible against the danger of such succulent masses being eaten by animals; this was effected by simulating in appearance the pebbles amongst which they grow.

Mesembryanthemum truncatum grows amongst rolled, water-worn pebbles, which it so closely resembles in form, colour, and mottling of the surface, that it is very difficult to distinguish between the two.

Mesembryanthemum bolusii is even more difficult to detect in its natural surroundings. The mimicry is with angular rock-fragments instead of water-worn pebbles. The plant consists practically of two fleshy leaves of a dull grey-green colour, and the resemblance is enhanced by minute pustular spots, with which the surface of the leaves is studded. The general effect produced is that of a lichen (*Lecanora*) growing on weathered stones. This plant is rendered conspicuous for a short period by its bright yellow flowers.

In a third plant, *Anacampseros papyracea*, also a native of the Karru, the leaves are minute, and are concealed by their large, dry, membranous stipules. The general appearance of the plant is compared to the dejecta of some bird, the branches becoming whitened towards the tips. In this instance, the flowers are very minute, and concealed under the stipules.

New Rubber Producing Plants.

In a Parliamentary Report of a Botanical Mission through the forest districts of Buddu and the Western and Nile Provinces of the Uganda Protectorate, Mr. M. T. Dawe announces the discovery of a considerable number of forest trees, many of which are of considerable economic importance. One of the most important results of the mission was the discovery that the Lagos silk rubber tree, *Funtumia elastica*, was a native of Uganda. During previous years considerable expense had been incurred in introducing this tree for the purpose of forming experimental plantations. This lack of information in the present instance has a compensating advantage, as, had its presence been known to the natives, it would probably soon have been exterminated, judging from the reckless manner in which they collect rubber from other trees.

Two more trees, present in abundance in various districts, *Landolphia dawei*, and *Clitandra orientalis*, will, in the near future, form important sources of Uganda rubber.

Numerous kinds of forest trees, many of gigantic proportions, were observed during the journey, a good percentage of which proved to be new to science. As examples:—

Balsamocitrus, the type of a new genus, has large globose fruits, and the seeds are embedded in a very fragrant balsam. *Canarium Schweinfurthii* is a large tree with an edible fruit containing a quantity of fragrant balsam, used as a substitute for incense in some Catholic churches.

Peucedanum fraxinifolium, a large, umbelliferous shrub, forms a favourite food of elephants.

Balanites wilsoniana, another tree hitherto unknown, has a large fruit, enclosing a seed full of oil. Elephants are very fond of the fruit, and are mainly responsible for its distribution throughout the forest.

Finally, a large toad-stool, common in some districts, furnished with a tapering stem two to three feet long, which penetrates the soft humus of the forest, is used as an article of food by the natives. This also proved to be undescribed, and has been named *Collybia macrorhiza*.

Arctic Flora.

Mr. H. G. Simmons has contributed an interesting account of the higher plants inhabiting the polar region, in *Videnskabs-Selskabet* of Kristiania. Ellesmereland, the northernmost great island of the Arctic-American Archipelago, was the portion investigated, and up to the present has furnished 115 species, belonging to 24 families. The genera containing the largest number of species are *Carex* and *Saxifraga* (11 each); *Ranunculus* (6); *Draba* and *Poa* (5); *Pedicularis, Potentilla*, and *Glyceria* (4 each). Of these, only two genera, *Androsace* and *Chrysosplenium*, and the following species, *Alsine Rossii, Carex membranopacta, Taraxacum pumilum*, and *Poa vagans*, are absent from Greenland. Of the Ellesmereland flora, 72 species are circumpolar plants, spread all over the Arctic region, and also to some extent, outside.

In tropical and temperate regions, it is well known that altitude is a factor of primary importance in determining the distribution of plants. In Arctic regions, this fact does not hold good. The author states that height is of very little consequence, perhaps none at all in these regions. At an elevation of a thousand feet the same species, under favourable conditions, were quite as large and vigorous as when growing at the sea level.

The two important factors are water supply during the period of growth, and exposure. Southern slopes, with the requisite amount of water, always furnished the greatest variety and abundance of vegetation.

CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

The Effect of Blows on Chemical Elements.

It was noticed by Herr Doermer that when metallic calcium was hammered on an anvil there was frequently a fairly violent explosion, accompanied by a flash of light and sparks, and it was found that the explosibility was promoted by the presence of rust on the anvil, or by traces of iron oxide as impurities in the metal. Professor Cohen suggested that the explosion might be due to the calcium having absorbed gases, just, as is well known, platinum can do, and experiments showed that calcium was able to occlude a considerable amount of hydrogen. The more extensive observations independently made by Dr. Ohmann, and recently published in the *Berichte* of the German Chemical Society, suggest that in some cases, at all events, the explosion of calcium is due to a vaporisation of the metal near the edge, where the pressure is greatest, and a combination of the vapour with the atmospheric oxygen. If the calcium be hammered in oxygen the flash produced is much more brilliant, while if the metal be struck with a rounded hammer only a faint light is observed, for then there is less vaporisation at the edges. When several slight blows are given in succession there is an accumulation of heat, and eventually a gentle blow may then cause an explosion. Similar phenomena occur in the case of other metals. Sodium hammered on an anvil gives out a bright flash, and small yellow flames are sometimes produced. Potassium gives marked effects with almost every stroke of the hammer, small violet flames with clouds of strong-smelling vapours being formed, while small incandescent fragments may be split off by sharp blows. Lithium also gives brilliant flashes, frequently accompanied by a report and by sparks. The light emitted is much more intense than in the case of potassium. Powdered aluminium and magnesium only give small sparks, and do not explode. Of the non-metallic elements tried by Dr. Ohmann only phosphorus gave a positive result. It was expected that the blow would cause the phosphorus to ignite, but instead of this it was flattened out into a dough-like mass and emitted sparks.

Liquid Nitrogen.

Dr. H. Erdmann has recently investigated the properties of liquid nitrogen more fully than had previously been done. It is a clear, mobile, colourless liquid which differs greatly from liquid air in its physical properties. It produces a much greater lowering of temperature on evaporation, and is thus a good cooling agent. When it is poured over a bulb of oxygen the gas condenses in bluish drops on the inside of the glass. Liquid nitrogen is a good solvent for liquids that boil at a low temperature. It mixes readily with liquid ozone. As a chemical agent it is as indifferent as gaseous nitrogen, and burning magnesium wire plunged into it is immediately extinguished. When poured over metallic calcium, however, it enters into combination to form calcium nitride, which yields ammonia on treatment with water.

The Dangers of Tinned Meat.

The exposure of disgusting practices in connection with tinned meat has naturally frightened many a consumer, although under proper supervision this method of preserving flesh should be quite free from objection. It is, therefore, of special interest at the present time to see what risks are run in eating such meat. It is asserted that the flesh of animals suffering from tuberculosis and other diseases is frequently used in these preparations. Although in the case of tuberculosis the practice is very objectionable, there would seem to be little risk of the flesh of an uninfected part of the animal conveying the disease to man, and even when the disease was general thorough cooking would destroy the bacilli and probably the toxic substances produced by them. There is, however, much more danger in eating the flesh of animals infected with the various bacteria that produce septicaemia, since their toxic products are only partially destroyed by heat. The flesh of animals suffering from anthrax, malignant œdema, and chicken pox is also dangerous whether in the raw or cooked condition. But this danger is one to which the consumer of fresh meat is also liable, whenever the system of inspection is defective. A greater danger in tinned meats than the presence of disease organisms and their products is that flesh containing putrefactive products may have been used. Wholesale putrefaction of the contents of the tin would, of course, make itself known when the tin was opened, but this would not be the case if flesh in a state of incipient decomposition had been used, for the sterilising process would have arrested any further change. The meat in the tin might, in fact, be absolutely free from bacteria, and yet be poisonous. The products formed by the bacteria are even more dangerous than the organisms themselves. Thus, in Germany, there have been wide-spread epidemics of what is known as *botulism*, a severe form of poisoning through eating raw or imperfectly cooked sausages. These have been found to be due to a definite toxine produced by *Bacillus botulinus* in flesh from which air is partially excluded. This toxine has also been found in poisonous hams, but as it is destroyed by heat it is not likely to occur in tinned meat that has been properly sterilised. But there are numerous other bacterial products—the ptomaines—which, unlike true toxines, are not destroyed by heat, and it is to one or more of these that most of the not very frequent cases of poisoning by tinned meat can be attributed. Many of them are simple substituted ammonias, such as *putrescine*, $C_{12}H_{12}N_2$, while others contain oxygen. *Cadaverine*, *neuridine*, and *saprine* are diamines, allied to *putrescine*, and, like it, are only slightly poisonous, but *methyl-guanidine*, $C_2H_7N_3$, which has been isolated from decomposing horse flesh and beef, is extremely toxic, and when injected into a small animal causes death within 20 minutes. *Neurine*, $C_5H_{13}NO_3$, a ptomaine formed on the fifth or sixth day of putrefaction, is also very poisonous, while *muscarine*, $C_5H_{15}NO_3$, from decomposed fish, is still more deadly. It appears to be largely a matter of time whether or no a particular ptomaine is produced among the continually changing products formed by putrefactive bacteria, and hence if there be truth in the report of unclean conditions in the factories it is by no means unlikely that particles of very dangerous flesh may become mixed with the fresh meat in the canning process. This may be regarded as the chief danger of tinned meat, and the only means of guarding against it is a thorough and systematic inspection of the factories, so as to insure absolute cleanliness.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

About Dew-Ponds.

IN reviewing a book in the May number of "KNOWLEDGE" on neolithic dew-ponds and cattle-tracks, I referred to the statement made by Dr. Hubbard that there was a wandering band of men who were going about England, in whom was vested the secret of making these ponds. The object they aimed at was to cause an artificial precipitation of dew by a combination of thatch and puddle. It would be interesting to know more of the people who are said to be occupied in this pursuit. At a paper read at the meeting of the S.E. Union of Scientific Societies at Eastbourne last month, Mr. Jenner referred to these ponds, and also to a builder at Alfriston who was stated to be engaged in making them. In visiting this maker of ponds I found that all that he had made had merely received a foundation of concrete, whether they were situated on high or on low ground. A dew-pond is a definite kind of pond, and must be regarded as quite apart from those which are merely made with an impervious bottom, and depend on rain and runnels for their supply. It is obvious that a pond situated on the top of a chalk down may receive a slight addition to its sum from the rainfall upon its surface, but natural runnels to feed it would be impossible upon so pervious a soil. Such would not be entitled to be called dew-ponds, unless it were known that the supply was attributable to an artificially-induced precipitation of dew.

Ponds on Worms Heath.

In "Neolithic Man in North-East Surrey," by W. Johnson and W. Wright, a cheaper re-issue of which we are glad to welcome, mention is made of a dew-pond on Worms Heath, and the suggestion is made that by puddling the bottom, a pond was formed in the depression of a neolithic hut-circle. I am not sure from the context that one can be quite satisfied that this is a true dew-pond, since with the removal of the shingle the clay bottom has, in some of the gravel pits on Worms Heath, resulted in a good deal of water lying stagnant there, and this pond may, perhaps, have formed spontaneously. On page 47 of the same book the authors refer to the strange sight seen in some parts of carts being sent up hill to obtain water from dew-ponds, or mist-ponds as they have often been called. It may, perhaps, be suggested that the immortal Jack and Jill obtained their supply from a dew-pond, since they were compelled to go "up the hill." Gilbert White makes some interesting remarks concerning one which was situated on Selborne Down, 300 feet above his house. It was never above 3 feet deep in the middle, nor more than 30 feet in diameter, yet it was never known to fail, though it afforded "drink for three or four hundred sheep, and at least twenty head of cattle beside." Unfortunately this pond when last I visited Selborne had at length become dry.

The Connection of Volcanic Action with Earthquakes.

In considering the many earthquakes shocks, small and large, which are constantly adding their quota to the tremulous condition of the globe, one cannot but be struck by the ignorance in which we still remain as to the constitution of the earth's interior whence such shocks originate. Certain lines of weakness, as they are called, present themselves on the surface, and these are marked by active volcanoes, and for the most part they appear in those parts where, so far as we can judge, the crust has been weakened by denudation, or where the fall is very rapid from a great height to a great depth, as on the Pacific slope of America. Earth tremors are closely connected with invisible intrusive volcanic action, and this results from contraction brought about by the cooling of the globe. It is not easy to imagine volcanic action without shocks, but on the other hand shocks may be felt, the connection of which with volcanic action is not so apparent.

Whence the Lava may be Derived.

For the supply of eruptions Mr. O. Fisher imagined a liquid zone at a depth of about 30 miles, although its depth would not be constant. A chilling at the surface due to removal of material by denudation would result in a depression of the boundary limit, whilst on the other hand, a deposition of some thousands of feet of sediment would cause it to be raised nearer to the surface. By this means we should have what has been called the "melting off of the roots of mountains," and this would, in a way, account for the smallness of the deviation of the plumb line when tested with a mountain mass. When, too, one sees the enormous foldings and contortions of palæozoic and archæan rocks, one may well ask how such foldings would be possible, unless the strata were in touch with some fluid mass yielding to the superincumbent mass and its movements. Some of the overthrusts, of enormous extent, with which we are familiar in pre-Cambrian rocks, almost baffle one if one is to consider them as having taken place while the rock was as solid as we now see it. Grant for a moment that it became partially involved in a great melting process, consequent on the rise of a heated liquid zone, and the foldings assume a more-to-be-expected aspect. In the rise of such a zone, strata would not necessarily lose its stratified form, although it would become of a plastic consistency. All kinds of gradations would afterwards appear in such rocks when they again cooled, and these would give rise to those metamorphosed rocks which it is impossible to classify either as igneous or sedimentary.

Why Lava Rises in a Volcano.

Occasionally portions of sedimentary rocks are erupted from a volcano, but with these very occasional exceptions the lava, scoriae, &c., which are erupted, and those intrusive rocks which do not reach the surface, may be held to represent part of the original, unaltered, material of the globe. Water plays the part of the explosive agent, and in later stages may assist in the welling of the material up the volcanic neck, after a rupture has been made, and a weak spot has thus been discovered. Different kinds of igneous rocks may be due to an actual stratified arrangement of molten material brought about by differences in specific gravity, at some time subsequent to the original condensation of the globe. There must, however, be some stress or strain to produce the necessary pressure or squeezing power for the upward flow, and no cause has so far been discovered other than that furnished by the secular cooling of the planet.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Jackass Penguins on Dassen Island.

AT the last meeting of the British Ornithologists' Club, Mr. Meade Waldo—who with Mr. M. J. Nicoll accompanied Lord Crawford on his winter cruise in his yacht the "Valhalla" in the capacity of naturalist—gave a most interesting account of the vast breeding colony of the Jackass Penquin on Dassen Island off the Cape of Good Hope, and commented on their extraordinary tameness. Though this colony was estimated to contain about 40,000 birds, it would seem that its ultimate extinction is within a measurable distance, since the eggs of these birds are transported annually in enormous quantities to the mainland.

Cape Cormorants were also breeding here in thousands; but they are carefully protected for the sake of the guano. On this account the presence of Sacred Ibises in their midst is regarded by owners of the island as objectionable, since they prey, or are believed to prey, on the young Cormorants. They are also said to live on the food brought by the Cormorants for their young, though how this is obtained was not apparent.

Migration of Swifts.

Colonel Yerbury at the meeting just referred to called attention to the enormous flocks of Swifts and Swallows which gather at Torcross in South Devon on their southerly migration. From August 5 onwards, for about a fortnight, Swifts are to be seen here in hundreds, and after their departure Swallows assemble here in thousands.

We draw the attention of our readers to this spot, since those interested in migration will probably find a rare opportunity of adding to our knowledge of this mysterious instinct, by a stay in this neighbourhood.

Curious Nesting Place of a Goosander.

Herr Zollikofer in a recent number of the *Schweizerische Blätter für Ornithologie* describes a case of a Goosander which nested in a hole in the roof or tower of a manor house at Werderberg. The height of the tower is 100 feet, and the young were in due time brought down to the gronnd in safety by the parent—it is supposed in her bill.

Blue-Throated Warbler in Norfolk.

The Rev. M. C. H. Bird writes to the *Field*, May 26, to say that he saw, several times during the 16th-17th May, a Blue-throated Warbler in the neighbourhood of Hickling Broad. As this bird, during the autumn at any rate, is fairly common during certain years in parts of Norfolk, it is possible that, if unmolested, spring migrants may be induced to breed here.

Pallas's Sand-Grouse in East Lothian.

According to a note by Mr. C. S. Chambers in the *Field*, June 2, a flock of six Pallas's Sand-Grouse (*Syrrhaptes paradoxus*) was flushed by him when playing golf over well-known links in East Lothian. There seems no reason to doubt the accuracy of this record, especially after the description of the birds which supplements this note. They would appear to have been frequenting this ground for some time, and to have been seen on several occasions by one of the "caddies."

Fire-Crest Nesting in Skye.

The *Field*, June 16, contains a note by the Rev. D. De Mackinnon on the nesting of the Fire-crested Wren in Skye. On May 19 the writer saw a bird of this species sitting on her nest near Portree, and since then it seems three other nests have also been found. The "hen bird being very tame every opportunity was afforded of observing her on the nest." But for this assurance we should have felt inclined to believe that the Gold-crest had been mistaken for its rarer ally. And even now we cannot resist a suspicion that some mistake may after all have been made.

PHYSICAL.

BY ALFRED W. PORTER, B.SC.

On Japanese Mathematics.

THE following is from a paper by Professor Harzer, read last year before the Mathematical and Physical Section of the British Association, the Annual Report of which has just been issued:—"Concerning the Japanese numerical value of π, that is to say of the ratio of the circumference of the circle to its diameter, we have knowledge of the fraction 79/25, about the year 1627. On expressing this value in the decimal system of numbers, in use in Japan since olden times, the first two places are right. To the second half of the 17th century belong decimal values of the precision of 9 and 10 places. About 1709, there is to be found the famous fraction, 355/113, right to 7 places, and about 1722 and 1739, the precision increases to 42 and 51 correct places. Moreover, about 1766, the two common fractions

$$\frac{5419351}{1725033} \quad \text{and} \quad \frac{428224593349304}{136308121570117}$$

were known, representing π with astonishing precision to 12 and 30 places; and already about 1760 there exists the value, 98548/9985, for π^2 which is exact to 9 places."

The Black Spots in thin Liquid Films.

It is generally asserted that very thin films behave as perfectly transparent bodies, that is, that all the light is transmitted, and in consequence none is reflected. But Dr. Johannott has shown that there is more than one "black." The first found varied in thickness between 40 $\mu\mu$ and 12 $\mu\mu$. The first black was found to break naturally into the other when the atmosphere was incompletely saturated. With a thoroughly enclosed film, it was necessary to heat the system in order to form the second black film, which had apparently a constant thickness of 6 $\mu\mu$ in all cases.

Recently (*Philosophical Magazine*, June, 1906), he has discovered that great changes in the character of these films could be produced by changing the pressure on the atmosphere surrounding the films. A sudden increase in the pressure was accompanied by a rapid thinning of the film while on the other hand a sudden diminution of the pressure was accompanied by a corresponding rapid increase in the thickness. On subjecting the first black film to sudden increases in pressure, it was possible to convert it quickly into a second black; if then the pressure was suddenly diminished, the second black became a first black. In many cases it was possible to continue this thickening until the film showed the yellow of the first order. These changes are attributed to the heating (or cooling) produced by adiabatic compression (or expansion). The heating produced by compression is accompanied by an increased vapour pressure, and consequently evaporation takes place from the surface of the film; while on the other hand adiabatic expansion causes cooling and condensation on the film. Measurements of surface tension show that there is no discontinuity in the surface tension corresponding to the discontinuity in the thickness at the junction between the two black films. When the second black is obtained by slightly increasing the pressure, it appears as small, perfectly round, black spots in the first black film, which expand to replace the first black as the pressure is increased. If then, the pressure be slightly lessened, perfectly round spots of the first black will appear in the film of the second black.

The solution was made in the following manner:—7 grams of oleic acid (refined) and 2 grams of caustic soda are thoroughly boiled in about 100 c.c. of distilled water. This gives about 7.5 grams of oleate of soda, which is diluted to about 50 of water to 1 of soda, and again boiled. An excess of acid is not harmful, while an excess of soda is decidedly so.

The Effect of Sound on Water Jets.

A problem which has been the subject of much discussion is the external reality (or otherwise) of difference-tones. These notes have a pitch which is the difference of the pitches of two sources of sound, which are acting together, and the question in dispute is whether these are produced externally to the ear or are due to the mechanism of the ear itself. Some experiments bearing upon this question have recently been made by Mr. Belas, as a development of experiments of Professor W. F. Barrett. When a jet of water falls upon a membrane while a tuning fork is sounding in contact with the support of the jet, it excites a sound of the same pitch in the membrane, owing to the jet being broken into drops at intervals corresponding to the frequency of the fork. When two forks of pitches 384 and 512 vibrations per second influence the jet, the note given by the membrane has a pitch of 128, that is, two octaves below the higher fork. This effect is produced even when the notes of the tuning forks themselves are nearly inaudible. When instantaneous photographs of the jet are obtained, with each, and with both the forks sounding, the spacing of the drops corresponds with the separate pitches and with the difference-tones respectively. Now, the peculiarity of this experiment consists in that the difference-tone is heard even though the generating tones have disappeared. This then, seems to be a case in which the explanation given by Helmholtz cannot possibly be true. Helmholtz considered that they are in all cases produced only when the generating tones are intense, and are indeed due to the failure of the law of simple proportionality between force and displacement. The explanation given by the authors is more in accordance with the original explanation of Dr. Young. When two notes are of different pitch there are moments at equal intervals at which the resultant amplitude of vibration is greatest, *i.e.*, whenever both notes are in the same phase. The number of such events per second is equal to the frequency of the difference-tone; and it seems possible that the ear picks out these rapidly recurring, intense sounds, neglecting those which are feeble in comparison; and, if they recur sufficiently rapidly, interprets them as a musical note. An analogy of the action has been given by Professor Poynting. "Suppose a reservoir is at the sea-shore, just below the level of the highest spring-tide, and with some contrivance for emptying it slowly. Then it will fill once a fortnight, and its rise and fall will have a frequency equal to the difference in frequencies of the solar and lunar tides. Its oscillations will, of course, not be harmonic, but its chief vibration will be fortnightly."

ZOOLOGICAL.

By R. Lydekker.

Butterfly Swarms

The April number of *Spolia Zeylanica* (of which the Editor has received a copy) contains an interesting account, by Mr. E. E. Green, of the enormous swarms of white and yellow butterflies which make their appearance every spring and autumn in Ceylon. In a space bounded by two points 30 feet apart and 12 feet from the ground it was calculated that about 150 butterflies passed, on an average, every minute. From this it was estimated that the number of butterflies passing in one direction between two points a mile apart and 12 feet from the ground would be 26,400 per minute, 1,580,000 per hour, and 6,330,000 between the hours of 11 a.m. and 3 p.m. on one day alone.

The Cairo "Zoo."

From the report for last year (of which a copy was sent to the Editor) it is satisfactory to learn that the Zoological Gardens at Giza, near Cairo, under the superintendence of Captain Stanley Flower, continue to make satisfactory progress, despite some losses from unfavourable weather.

Okapi for the British Museum

Captain Gosling, now on the Congo frontier, has already sent to the Natural History Branch of the British Museum a complete skin of the Nigerian giraffe, as well as specimens of many other mammals, and we now learn that he and his companion, Captain Alexander, have succeeded in procuring an okapi skin for the national collection. These two explorers seem to have come into very close contact with the animal, and have furnished some important information with regard to its habits; but the actual trapping was accomplished by a Portuguese collector accompanying the expedition.

Some New Mammals.

Mr. O. Thomas, of the British Museum, has recently been enabled to describe quite a number of new genera of small mammals. Among the more recent additions to the list is a mouse from Persia, for which the name *Calomyscus* has been proposed; this species being of special interest on account of the fact that it is totally unlike all other Old World mice and near akin to North American types, more especially *Peromyscus*. A second novelty is a new genus (*Platymops*) of free-tailed bats from North-East Africa, this bat being distinguished from its relatives, the mastiff-bats (*Molossus*), by the absence of wrinkles in the lips and the curiously flattened head. Here, too, may be appropriately noticed the description by Mr. R. B. Kinnear of a new race of British field-mouse (*Mus sylvaticus fridariensis*) from Fair Island, south of the Shetlands.

Papers Read.

At the meeting of the Zoological Society held on May 1, the Hon. Walter Rothschild read a supplemental paper on gorillas and chimpanzis, at the same time exhibiting a splendid series of specimens mounted for his museum at Tring. All the gorillas were referred to a single species, with several sub-species, the typical race being represented by a dark-headed and a red-headed phase. Australian mammals formed the subject of a paper by Mr. O. Thomas, while Mr. F. E. Beddard contributed information with regard to the anatomy of snakes. Mr. H. J. Elwes, Sir George Hampson, and Mr. J. H. Durrant severally read papers on the butterflies and moths collected during the recent expedition to Tibet. At the meeting of the same body on May 15 Mr. Thomas read a further paper on Australian mammals, while Mr. R. I. Pocock discussed the breeding habits of certain monkeys in the Society's menagerie. On the same occasion Mr. J. N. Halbert described water-mites from Lake Nyasa, Messrs. Benham and Dunbar contributed notes on the skull of a ribband fish, Dr. von Linstow discussed hair-worms from Korea, while Mr. G. A. Boulenger communicated an account of certain new reptiles from Uganda.

The Artificial Generation of Life.*

By GEH. RATH PROF. DR. W. ROUX.
[*With a note by J. Butler Burke, M.A. (Camb. & Dubl.)*]

(Reprinted from the "Umschau," 1906, No. 8, the weekly journal of the work and progress of the combined departments of Science and Technical Knowledge (Frankfort a./M., H. Bechhold).

THE political newspapers and popular science journals are publishing accounts of the artificial generation of life and exciting universal amazement amongst their readers. The element of amazement arises, however, mainly from the interpretation put upon the matter by the imagination of the writers of these accounts; the experimenters themselves speak with considerably greater caution.

According to a communication in the English periodical *Nature*, No. 1,856, May 25, 1905, Mr. John Butler Burke sterilised some gelatine and placed it in a small tube with radium salt. After twenty-four hours there appeared on the surface of the gelatine a peculiar culture-like growth which gradually made its way downwards into the gelatine. When examined under a microscope a distinct growth was apparent; this was followed by subdivision of the circular bodies when they had reached a certain size, viz., 0.0003 mm., and they often took a rosette-like arrangement. Mr. Burke thinks the name *Radiobes* (Radium organisms) might be given to these bodies. Professor Sims Woodhead asserted that their resemblance to bacteria is only an apparent one. He showed that the forms, when removed to fresh gelatine, increase still further in size, and that on heating the cultures till the gelatine dissolves they disappear, but become visible again after a few days.

Mr. Littlefield is stated to have obtained a similar result by quite a different process. To a 33 per cent. solution of common salt there was added the same volume of 90 per cent. alcohol. Small quantities of this mixture were placed in watch-glasses, a little ammonia was added, and the whole covered with a bell-glass. In half an hour drops were visible on a slide with the aid of a microscope. Crystals of common salt settled out first, then crystals from which emerged small oval or round forms which are alleged to be living organisms, since they grow, and, like amœbæ, send out moving processes.

But, assuming that the account of the directly observed results of these two experiments is absolutely correct, the conclusion drawn from them, that forms corresponding to living organisms have been obtained, is by no means justified.

These unjustifiable conclusions arise from the want of a *complete definition of life in its simplest form.* A quarter of a century ago I formulated such a definition[1] of living organisms on the ground of their peculiar property of self-preservation and the persistence of their species through the ages, notwithstanding alteration of material and environment, and I have recently more completely established this definition.

It is impossible to make a purely chemical definition of life, such as has long been sought, because life is intimately bound up with those physical aspects which are not merely the result of the chemical constitution, but rest also on a special physical structure. The definition of life can at present only be made on the basis of the *activities* of the living organisms, so far as we know them. Such organisms, at their simplest, are natural bodies which (1) absorb foreign materials into themselves (*absorption*), and (2) convert them into substance resembling themselves, assimilate them (*assimilation*); (3) change themselves by means of processes taking place within themselves† (*Dissimilation, e.g.,* consumption of albumen, fat, &c.), or, on the other hand, may remain entirely or almost entirely unchanged (4) by spontaneous secretion of the altered material (secretion of carbonic acid, urea, &c., in animals, of oxygen, &c., in plants), and (5) by *spontaneous repair* through absorption and assimilation of food; and (6) may grow by over-compensation in the repair of the used-up material (*spontaneous growth*); further, (7) from causes lying chiefly in themselves they are able to move themselves (*spontaneous movement, reflex movement*), and are also able (8) to subdivide themselves (*spontaneous subdivision, spontaneous multiplication*), and (9) to transmit their characters entire to the organisms which spring from them (*transmission*). It remains to urge emphatically that *all* these long-known activities belong together, and that they are in their own way *fixed, determined, in the organisms,* even though their perfection is often dependent on external factors, and though their activities are somewhat modified by external influences. The *sum* of these activities is what determines the character of the living organism, as well as the *highly developed faculty of self-preservation.* Living organisms are primarily concerned with the renewal and preservation of their species, and when food is present they take what is necessary to maintain their own existence.

Forms exhibiting the activities here enumerated would certainly be accepted as living organisms. But there is yet another essential property of all forms of life, even the lowest: (10) *the spontaneous regulation of the exercise of all specific activities;* the more, for instance, they are deprived of food, the greater is their desire for it; when a certain quantity has been absorbed the capacity for absorption is diminished; the more foreign materials have been formed, the more possible is it to secrete them, &c. By means of this power of regulating function, which, of course, is not without its limits, the faculty of self-preservation, and with it the *persistence* of the organisms, is substantially increased; indeed, when changes occur in external relations, this power is indispensably necessary in order to prolong existence. We must, therefore, regard the *spontaneous regulation of function as a further "primary property"*

Translated by Miss E. Slater.

[1] "The Struggle of the Parts in the Organism," Leipzig, 1881. Also in "Collected Treatises on the Mechanics of Development," Vol I., p. 387. 1895.

* "Suggestions on the Mechanics of Development: I. The Mechanics of Development, a new Branch of Biological Science," p. 105. Leipzig, 1905.

† In the lower organisms dissimilation is not an absolute and continuous process as it is amongst warm-blooded animals, but it is essentially conditioned by the using up of energy and the wear and tear of the machinery through action. Many experiments made on cold-blooded animals, as for instance by drying and freezing, indicate complete suspension of metabolic changes. The continuous destructive decomposition of the warm-blooded animals, however, assists in self-preservation, since but for the maintenance of a higher temperature their machinery would not perform its functions and they would consequently be incapable of self-preservation.

of the living organism. With it is associated also the *power of adaptation* to changing external relations (for instance, to change of the accessible food supply) and, amongst higher forms, to changes of climate, to changes of habitat, to or from a flat or a mountainous region; that is, to the consequent alteration in the mode of life and in the various instinctive activities. It is only by means of this power of adaptation that self-preservation becomes possible in the face of changes in these relations.

Since all this adaptability (conformability), as it is called, in the activities of the organisms, serves only to prolong their existence, it is more appropriate to speak of the *persistence* than of the *adaptability of the organisms*, and to speak of their *recuperative and progressive activities* rather than of their adaptable activities, a suggestion (v. No. 1, p. 214) accepted by various authors (*e.g.*, Ostwald) and attacked by others (*e.g.*, Ed. v. Hartmann).

No form which does not exhibit *all* these activities can be described as even the lowest kind of living organism. But where these exist we need not concern ourselves with their origin or special chemical and physical nature. It is, however, essential that such forms should, in addition, possess special properties in order to continue their existence on the earth. They must, for instance, be insoluble in water, since they would otherwise be liable to be destroyed by the frequent rains, and so would not be able to persist through the centuries nor reach any further stage of development.

The higher organisms possess, in addition, many other properties, as, for instance, the power of assuming various forms (the *spontaneous development* of all characteristics of class, genus, species, &c.), and the manifold psychological activities, all of which are determined according to the substance of the organisms, but do not now concern us. To emphasise once more the essential point: the organisms participate in the renewal and preservation of all their special "typical" mechanisms of self-determination and self-preservation, as well as in the production of the outer factors which are determined from within; that is, which depend on their own physico-chemical structure. "Typical" in this definition is a more strictly limiting conception than "normal," which has hitherto been adopted.*

Turning now from what is known to the experiments of which mention has been made, let us ask whether the forms produced in each of the two experiments present *all* these primary activities of life.

Of Burke's forms it is only asserted that they grow and subdivide. We must, in the first place, enquire whether this growth is "spontaneous growth"; in other words, whether it takes place in accordance with the characteristic growth of the organisms by means of new living substance formed in and by the organism itself, by assimilation of other materials *within* the organism, and not, like crystal growths, consisting of accretion of external materials surrounding it, even though these materials have been produced by the influence of the form itself, or whether it depends only on a propagation of this influence, like the propagation of warmth, or of diffusion.

In the second place we must ask whether the subdivision of the forms which has been observed is really *spontaneous subdivision*, and whether it takes place by means of influences which are determined *within* the organism in accordance with its nature. On this point nothing is said, but it may, perhaps, be the case. It may, however, be remarked that apparent subdivision takes place under many conditions. For instance, if we place a drop of alcohol on water, or a drop of oil on a solution of soda, the drop divides very quickly, and apparently spontaneously, into four parts; in reality, however, it is divided by the influence of the surface tension. Nor is the rosette-like arrangement peculiar to or characteristic only of living forms.

It will be seen at once that the main point is absent in the "observed" activities of Burke's forms; the proof, namely, that these activities correspond to the same activities in the lowest forms of life, that they are, in fact, "spontaneous activities" of the organisms. Besides, it is not probable that the mechanism of the two very different "organic" activities, assimilation and spontaneous subdivision, could be effected in so direct a manner; that is, by the direct energy of radium alone. But even if this were possible and had here taken place, these forms might still be considered as very interesting *preliminary stages* of life, as "probionts" (*Probionten*), but not as representing even the lowest forms of life, for they are without the activities of spontaneous dissimilation, of spontaneous secretion of changed materials, and of the spontaneous movement which is characteristic of living organisms, as well as of the spontaneous regulation of the performance of all activities.

Although the results of Littlefield's experiments are said to be different from those of Burke's, they are yet less inconclusive as to the artificial production of living forms. I have repeated these experiments and obtained results which in many ways apparently correspond to those described, but I ascribe to them a wholly different significance.

On the saturated ammoniacal solution of common salt in alcohol many small separate forms appeared moving hither and thither. But scraps of filaments arising from the impurity of the liquid floated about in the same direction, thus showing that the movements of the individual forms are not active, but passive, depending on the motion of the liquid. This, however, is by the way.

On the evaporating circumference of the drop, crystals separate, many of which have an area of liquid which has either been left on them or has possibly caught on them or has run over them. Thus we have forms which closely resemble cells. The liquid area may also have processes which, in consequence of further drying or of the altered surface tension, change their form and so present the appearance of slow amoeboid movement. But in all these it is only a question of forms arising from unequal moistening capacity of the glass, or its unequal surface and unequal surface tension. Anyone can produce similar forms to any extent by pouring water over a glass plate held obliquely; after most of the water has run away such forms are visible to the naked eye. If there are on the glass plate small unevennesses or dusty spots which are more easily moistened, the liquid collects on these parts, and on looking at it from above we again have the cell form with the nucleus in the middle and processes outwards, the latter of which change their form on further contraction or moistening. These well-known phenomena show that forms may be produced resembling amoebae, but without their essential characteristics. Besides, the motion of amoebae often depends on alteration of surface tension through external causes. But in the case of their spontaneously regulated movements the movement is produced from within and is definitely characterised.

Moreover, numerous pale yellow, very small and

* See No. 2, p. 182.

round, or oval and flat disc-like forms were noticed, sometimes near these liquid area crystals, sometimes at a distance from them; these are probably Littlefield's organisms. To me they appeared to be residues left after evaporation, or deposits on dirty places on the plate. Perhaps they are partly produced like the flat drops which may be seen forming on the side of a vessel only partly filled with alcoholic liquid. Alcohol first rises invisibly, and gradually becomes visible on the sides; perhaps even a mist is deposited at a suitable temperature; in this way drops are formed which gradually increase in size; other drops are formed in the same way all about them, often appearing to issue from the earlier ones. These are well-known phenomena which, however, have nothing to do with specific organic "spontaneous growth." I have never seen any growth in the small pale forms which arise in great numbers as the evaporation proceeds, although I do not assert that such phenomena are impossible, for we know that instances of the kind may be found in similar artificial forms. The deposited drops just mentioned increase in size visibly; this, however, is not spontaneous growth, but passive growth, according to my definition. On large freshly-moistened glass surfaces division of the liquid used for moistening is frequently seen. This division is caused by retraction of the layer of liquid at some points of closer adhesion. It is not, however, spontaneous division, but is division "effectuated" and determined from *without* and influenced by the exact degree of surface tension, and is not connected (through qualitative bisection) with transmission.

We often can produce no direct, but only indirect evidence of assimilation and of the spontaneous growth which depends upon it, as also of spontaneous division, in the actual lowest forms of life. In order to adduce direct proofs of assimilation it would be necessary to watch for days together to see that materials differing in appearance were taken into the organism, that these did not accumulate in large masses different from the rest of the organism, but gradually disappeared. Even then assimilation is only indirectly proved by the fact that the vital force, instead of being reduced by taking in so much foreign material, is, on the contrary, increased, inasmuch as subdivision of the organisms goes on. If this subdivision has gone on through *several* generations, and has always resulted in forms resembling the original in shape and function, then we have a clear proof of spontaneous assimilation and of spontaneous division.

The actual lowest forms of life exist for the most part in aqueous fluid and prove by the fact of their remaining intact that they are not soluble in it. The artificial forms spoken of, on the contrary, are soluble in water; they are incapable of maintaining their existence in it, and in this respect also they are lower in the scale than living organisms.*

* While this paper was in the press there appeared (in the Karlsruhe Journal) another communication on the same subject giving an account of some interesting observations made in the Physical Institute at Karlsruhe under the famous physicist O. Lehmann; it was also widely circulated under the misleading title of "A New Physical Wonder." It gave an account of drops which form buds and divide, then assume a worm-like shape and afterwards separate into many parts. They crawl about like the Bütschli drops mentioned, but more quickly. These forms, which seem to be produced mainly by changes in surface-tension in a manner which makes them appear almost typically peculiar, must also be tested as to the degree of their resemblance to living forms by the analytic method of examining functions given above; and the nature of the forces in question must be narrowly scrutinized and compared with the influences which have produced organic phenomena of a similar kind. Perhaps here we shall come upon the beginning of that spontaneous division which is essentially determined from within.

We have recognised, then, on the one hand, that the artificially-produced forms are devoid of the primary activities essential to even the lowest forms of life; and on the other hand there is no proof that the activities observed depend on the power of spontaneous determination which is characteristic of living organisms, or that they are capable of that spontaneous regulation which alone would enable them to persist throughout many changes in external relations.

The *inadequacy of the definitions of the nature of life* formulated and promulgated by philosophers, naturalists, and even some physiologists, is ultimately responsible for the unwarranted interpretation of these forms as being actual organisms of the lowest stage. They think that what is needed is something simpler, more universal, more direct, than what I have given above, *the sum of widely differing* individual activities and the spontaneous regulation of these. Even if we leave out of count those authors who take the supernatural view and would have a "purposeful agent" (conscious First Cause) in the processes which result in life, yet we cannot disregard those who believe there could be a "simple" chemical process or a simple physical agency which could produce all these activities. According to this view a "simple" experiment might happen to produce this direct agent and thus suddenly give rise to forms of life. But there is a fundamental error in this view. The sum of the different activities described above alone indicates the minimum of actual life, and only those forms which possess this sum of activities reproduce similar forms; nor does this reproduction depend on the aid of a purposeful agent, but, the forms once in existence, reproduction depends only on the pre-determining tendencies inherent in their material basis.

Admitting all this, however, it would be vain to assert that in principle we could never artificially create the lowest forms of life, perhaps with very slightly developed spontaneous regulation. This, however, cannot be done by a single experiment, but only by a *methodical series of experiments* in which we must first endeavour to produce forms with one or a few primary individual activities. The insight which has been gained can be turned to account by combining the successful results already secured. Only thus shall we be able gradually to produce bodies which will combine all the *activities* indicated above *which are necessary for self-preservation by the processes of change in material corresponding to change in external circumstances*, and which will then continue and multiply. Forms possessing certain of these activities, spontaneous movement, spontaneous absorption, and spontaneous secretion of material, have already been artificially produced by Bütschli, Quincke, Rhumbler, and others. Spontaneous chemical assimilation, spontaneous growth, spontaneous secretion of altered material, and a certain amount of spontaneous regulation in assimilation and secretion are typically represented in the processes of assimilation by heat. Since, however, the other activities of self-preservation are absent in bodies thus produced, their power of persistence is inadequate. As soon as cold assimilation processes of a suitable nature (according to Pflüger, cyanide compounds) are employed, it is possible that high preliminary stages of life might be produced artificially by combining these with the processes for the last-named forms. Spontaneous division, spontaneous regulation, and "morphological assimilation," which presents special difficulties, would then follow. We shall then, perhaps, attain in the laboratory by observation and study in a relatively short time to what in nature has only arisen in the course of vast periods of time as the result of a fortuitous concurrence of circumstances and of a spontaneous storing up of the forms capable of self-preservation through changes in material and thereby of "persistence."

If, then, it is certain that the above-mentioned experimenters* have produced no actual forms of life, even of the lowest order, and have not solved the problem of the artificial creation of life, and if this problem cannot be solved by one kind of experiment alone by reason of the number of primary life-activities necessary even to the lowest organism, we must assume that further research will be necessary in order to ascertain how far the various experiments of these writers are a new and valuable contribution towards the solving of this problem by the slow method insisted upon above, namely, the combining of artificially produced individual activities †.

* Including Charlton, Bastian, Stadelmann. (MS. note.)

† This is practically the argument used in *The Origin of Life* which which has just been published. I do not think however it is likely that we shall succeed in producing artificial forms of life which would correspond to the organic types existing naturally in nature. The probability of hitting on the exact conditions would be infinitesimally small. The most we can hope to do, as I have tried to show, is to imitate these by approximation. The artificial types, of course, do not satisfy all the conditions of *natural* life, it all depends, therefore, upon what we understand by life. If a scale of gradually increasing complexity can be established, from the supposed inanimate to admittedly animate nature, there should be no reason why we should confine the definition of life to natural types which have survived on account of their fitness for their surroundings. As a curve may approximate to its asymptote, so may artificial life approximate to natural life. But as the latter is the survival of countless generations, it is likewise to be expected that it should be more perfect than anything that by artificial means we should ever hope to obtain. I believe the subdivision of the radio organism proceeds from the interior, as I have tried to show, and that the growth is not by accretion, but by assimilation, as in the case of most organic crystals. They appear to assimilate sulphur and other substances from the medium in which they grow.

The Hedjaz Railway.

By P. L. Sclater, D.Sc., F.R.S., F.R.G.S.

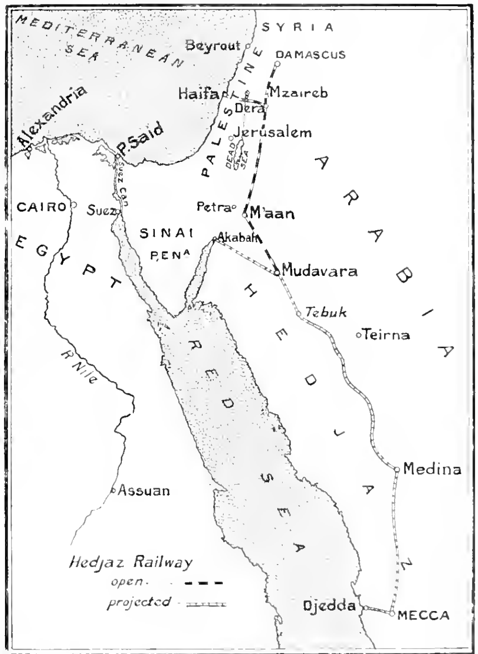
So little is known in Western Europe about the "Hedjaz Railway," which has been planned with the object of conveying Mahometan pilgrims direct to Medina and Mecca, and so saving them the danger and toil of a long overland journey, that some information on this rather mysterious subject may not prove unacceptable to the readers of "Knowledge."

Every Mussulman, as we know, is bound to undertake the pilgrimage to Mecca once in his life. And this pilgrimage properly begins at Damascus, where the holy tent is kept, although few pilgrims nowadays, except those who live in the district, go round by Damascus and perform the journey of 27 days overland, when they can be conveniently carried by steamer to Djedda, which is only 45 miles from the Holy City. The pilgrimage-caravan leaves Damascus with great ceremony once a year, at a period varying according to the Mohammedan calendar, and proceeds by the great pilgrim-route to Medina and Mecca.

The pilgrim-route (Derb-el-Hejji) is marked on most maps, and the railway, I believe, follows it very closely.

The exact inventor of the clever scheme of constructing a railway along the pilgrim-route from Damascus to Mecca is not known, but in Turkey is commonly supposed to have been the Commander of the Faithful himself; and this may well be the case, for the present Sultan is one of the most wary and capable of crowned heads, especially in matters relating to his own sovereignty. It is obvious that a railway made professedly to carry pilgrims would also be available to transport soldiers and military stores. And both these articles are much required in Central Arabia, where the continued and successful rebellion in Yemen has long been a source of great anxiety to the Sultan and his advisers.

However this may be, in May, 1900, it was announced in one of the official journals of the Turkish Empire that a railway was to be made from Damascus to Medina and Mecca, and the whole Mahometan world was invited to contribute every possible assistance to this pious work. This good news was greatly appreciated



by the Mahometan press, and was spread abroad not only over Turkey, Egypt, and Arabia, but throughout the eastern world where there were adherents of the Islamite faith. The great advantages of the new scheme, religious, political and economical, were duly dwelt on, and the Hedjaz Railway was lauded as of equal importance to the Suez Canal.

To commence the work six Mussulman engineers were assembled (not without some difficulty), and despatched to Damascus to make a preliminary survey, and it was agreed that all materials for the holy project should be supplied exclusively by Mahometan factories. Three new railway-battalions of soldiers, each a thousand strong, were raised to act as "navvies." But it was soon discovered that, though the Turks might be efficient as navvies, they could not make rails or build locomotives and trucks, and it was found necessary to go to Belgium and Germany for a supply of these requisites. It was also quickly shown that the native engineers were useless, and their places were taken by Europeans from Italy, France, and Poland. A German engineer, Herr Meisner, was placed at the head of the railway-corps.

Great efforts were made to raise the money required for this gigantic task. The Sultan set a good example by giving up a month of his civil list, amounting to 50,000 Turkish livres, and a tax of 10 per cent. on all salaries was levied in aid of the undertaking. Besides this, large donations were received from all parts of the Mussulman world, especially from India and Ceylon. Mirza Ali Bey, of Calcutta, sent a donation of £5,000 to the holy work, and promised further advances, and large sums were also received from Australia, Singapore, and Natal.

On September 1, 1901, being the 26th anniversary of the Sultan's succession, the first portion of the new line (about 20 kilometres, between Mzaireb and Dera) was opened with great ceremony. Other portions followed suit from time to time, and the main line from Damascus to M'aan, a place about half-way between the south end of the Dead Sea and the north end of the Gulf of Akabah (conveniently near to the famous ruins of Petra), was sufficiently finished to carry slow traffic about a year ago. The length of the line, as shown by the subjoined list of the stations (kindly supplied to me by Messrs. Thos. Cook and Son), is 465 kilometres. Since then (as we were informed by the correspondent of the *Times* at Constantinople in December last) the line has been carried on for a further length of 150 kilometres to Mudavara, and it has been determined to build a branch line either from that place or from M'aan to the head of the Gulf of Akabah.

But a still more important event in connection with the Hedjaz Railway now remains to be mentioned. To connect the great city of Damascus and the fertile country around it with the civilised world two railways were originally planned—a French line to start from Beyrout and cross the Lebanon and Antilebanon, and an English line commencing at Haifa and crossing the Jordan south of the Sea of Galilee. The northern (French) line was quickly carried out, and for some years has been the established route to Damascus. The southern (English) line, ill-provided with funds and not in favour at Constantinople, has never prospered, and only a few miles of it out of Haifa were ever opened. Abdul Hamid realised the situation, and after a long bargaining with the concessionnaires, succeeded in buying up the undertaking and completing it from Haifa to Dera, a station on the Damascus-Mecca line, 123 kilometres south of Damascus. The Sultan will thus be able when the whole project is completed, to ship his pilgrims (or soldiers!) at Haifa and run them straight to Medina and Mecca. This will not only save the passage of the Suez Canal, which, as being under Anglo-Egyptian control, is not favoured by the authorities at Constantinople even for pilgrims, but will also enable troops and arms to be sent to Central Arabia without any risk of their being stopped or delayed in Egypt.

I am not much in sympathy with the Turk and his ways, but in the case of the Hedjaz Railway I think he has done a good work and deserves success. It may probably be some years before the line is completed to Medina and Mecca (!), but in the meantime a country very little known and hitherto very difficult of access has been opened up, and Petra and many other ancient sites along the route which it traverses will be rendered comparatively easy of access. Messrs. Thos. Cook and Son inform me that they are making arrangements whereby travellers will be able to visit the wonderful ruins of Petra by the Hedjaz Railway from Damascus to M'aan during the next season in Palestine.

There can be no doubt that the recent occupation by the Turkish forces of one of the ports at the north end of the Gulf of Akabah which is now producing much friction between the Egyptian and Turkish Governments, is caused by the anxiety of the Sultan to find a suitable opening for the Hedjaz Railway on that Gulf. If this can be secured the Porte will be able to send its troops and stores into Central Arabia without going through the Suez Canal, which might be closed at any moment in case of war.

List of the stations on the Hedjaz Railway :—

	Distance from Damascus in Kilometres.
Kaaden esh Shereef (Damascus)	
El Kieweh	20.80
Deir Ali	30.50
El Miemiyeh	49.70
Jebah	62.60
Khubeb . ..	69.10
Mabje	77.85
Shakra . .	84.50
Ezra (Zorea)	91.25
Kharbet el Karaly . ..	106.10
Dera	123.00
(Junction with the line from Haifa)	
Nassib	135.35
Mifraka (Kelaat el Mefraak) .	161.70
Kharbet es Samra ..	185.30
Zerka (Kelaat es Zerka)	202.75
Ammon	222.40
Kasr el Ala ..	234.05
Leben	243.50
Djira . .	259.70
Dekaa ..	279.15
Ez Zebib . .	295.70
Katranek	326.60
El Khassa (Kalatel Hassi) ..	378.25
Jeroof ed Derursh (Wadi Benna)	397.80
Aneiza	425.25
M'aan	465.00

Plants and Frost.

According to Professor Wiegand, of Cornell University, it seems probably that frost causes the death of vegetation by causing the actual withdrawal of water to form ice *outside the cell*. The ice formation dries out the cells, and the plant suffers therefore from drought conditions. Every plant cell has its critical point, the withdrawal of water beyond which will cause the death of the cell, whether by ordinary evaporation or other means. It may be supposed that the delicate structure of the protoplasm necessary to constitute living matter can no longer sustain itself when too many molecules of water are removed from its support. In the great majority of plants this point lies so high that it is passed very soon after ice begins to form in the intercellular spaces. Hence the death of so many plants at this point. But other plant cells may be able to exist with so little water that a very low temperature is necessary before a sufficient quantity is abstracted to cause death. From some plants enough water cannot be abstracted by cold to kill them (many bacteria, it will be remembered, can endure the cold of liquid air). In rather dry tissues, as in some winter buds, a temperature twenty to thirty degrees below freezing may be required before the ice crystals can be seen in the tissue.

REVIEWS OF BOOKS.

ASTRONOMY.

Radcliffe Catalogue for 1900; of 1772 Stars, chiefly comprised within the zone 85° to 90° N.P.D. (Oxford, 1906, xxxvi. + 81; 15s. net). This volume, published by order of the Radcliffe Trustees, under the direction of Dr. Rambaut, the Radcliffe observer, contains the results of ten years' meridian observations with the Radcliffe transit instrument, formerly used by Carrington. Of the years in question, 1894 to 1903, the first two were mainly devoted to finishing off the previous Radcliffe Catalogue for 1890, and the last to dotting the i's and crossing the t's of the present one. The quantity of observations, even if wholly confined to the seven remaining years, is not by any means large, but it should be borne in mind that the staff is small, and has much other work to do, and that serious interruptions were caused by the death of E. J. Stone in 1897, and the appointment of his successor, who was, perhaps, inclined to be too sceptical as to the value and validity of his predecessor's work. Most of the stars in the present catalogue are to be found within the zone 85° to 90°, N.P.D., and it also contains all the stars legitimately included in the Nautical Almanac Zodiacal List. (N.A., 1897.)

It might at first sight be thought that Dr. Rambaut's remark on the first page of the introduction, as to the number of stars in the catalogue, is a rather clumsy paraphrase of the possibly sarcastic statement, "The observations, *though few*, are good." The real meaning of the sentence is that the observers did not endeavour to work against time, as they might have been tempted to do. Alterations were made in the floor of the room to increase the stability of the instrument, and various other improvements introduced into the system, notably a chronograph. It is not clear that the substitution of a circular mercury trough for reflection observations of stars is an improvement, as the dimensions are not given. For nadir observations, where the advantage of a circular trough is less questionable, the old rectangular one is still in use. It seems obvious that unless the circular trough is very large, its use for low stars is a great mistake, and if low stars were not observed, is it not surprising that the R-D discordance should be regarded as unsatisfactory? Very few stars were observed for Colatitude, so that it is quite likely that all the catalogue comparisons at the end of the introduction are systematically affected. It appears certain for instance, that the comparison with *Greenwich, 1890*, from which Dr. Rambaut professes to cast doubt on the validity of the Greenwich R-D correction, is erroneous, since the adopted colatitude at Greenwich is affected by R-D, and this point, as well as the effect of substituting Pulkowa refractions for Bessel's, seems to have escaped the Radcliffe observer's notice. There is a description of the determination of pivot-errors by a method devised by Dr. Rambaut, founded on that of M. Hamy, of the Paris Observatory. There is also a defence of electric control for chronographs, which, however, is not satisfactory, as it assumes that there is no lag in the changing speed gear, and that the observations are all read in accurately by proportional scale, which, though desirable, is only attainable when the number of registered observations is comparatively small, or the computing staff large and not busy. Our readers must not infer that we are objecting to the electric control so much as to the defence of it. Several pages are devoted to a discussion of the division errors of the circle, which leave the impression of a great waste of time. Stone's errors being under suspicion, the observations on which they were founded were re-examined, without the light of the knowledge as to their relative value, which Stone undoubtedly possessed, but did not record, with the natural result that by giving equal weight to most of them, a different set of corrections was obtained, and the also natural result that the differences were slight. Whereupon, as the old corrections were already in use, no change was made. It is difficult to see what change could have been made without repeating the observations themselves, as it could hardly be Stone's powers of computing that were under suspicion. We can appreciate the determination not to waste more time by altering the corrections, better than we can appreciate the devoting of several pages of introduction to the account of the investigation. Very few of the fundamental stars seem to have been really well observed in N.P.D. Possibly it was in this one unfortunate direction that the observers were encouraged to save time. In one place, Dr. Rambaut says: "The results are of a high order of accuracy, as is shown by the tests which have been applied," *i.e.*, the probable error is small; in another place he says: "The smallness of the probable error corresponding to the zone 120° to 122°, is obviously *an accident, due to the small number of stars which it contains.*" Are we to infer that the probable error of a single observation *must* be zero, or that the probable errors of the catalogue are small because the stars are few? Nearly all the stars in the catalogue have been observed three times at least in each element. Among the very few exceptions, we notice Sirius with only two observations. It seems a pity such a star was included at all, if so few observations were made of it, especially as it involved corrections for orbital motion and parallax. Reference numbers are given for each star to Auwers' Bradley (1755); Lalande (1800); Weisse's Bessel (1), (1825); Albany, A. G. (1875); Radcliffe (1890); Greenwich (1890); and Bonn Durchmusterung (1855), and notes are added on magnitude and colour, and authorities given for the adopted proper motions. We have nothing but praise for the general style and appearance of the volume, which is similar to the Radcliffe 1890 Catalogue. It will be interesting to compare the results with other catalogues of the same epoch when they appear, a time which should be fast approaching.

BIOLOGY.

The Dynamics of Living Matter, by J. Loeb. Columbia University Zoological Series (New York and London, 1906; pp. xi. + 233, price 12s. 6d. net).—Two transcendental problems, observes the author, confront the biologist at the present day, namely, the artificial transformation of dead into living matter, and the artificial transformation of one species of animal or plant into another. As to the first problem it is certain that no one has yet witnessed such a transformation, but since we daily see animals and plants converting dead into living matter in their own tissues, and since chemical processes are essentially the same in living and in dead matter, Professor Loeb does not despair of the discovery of abiogenesis, and urges that this should be the goal of every biologist. Incidentally he raises the question whether death is a necessary outcome of development, and whether rejuvenation and the commencement of a new cycle are impossible. As to the second problem, this has undoubtedly been solved by de Vries's famous experiments of primulas, and, if plant-species can be artificially produced, why not animal species? The chemistry of living organisms, the general physical constitution of living matter, the more important physical manifestations of life, the influence and effects of electricity, heat, and light upon living matter, the phenomena of "heliotropism" (turning to the sun), the nature of fertilisation and regeneration processes form the subject of the various chapters (originally lectures) which go to form this thoroughly philosophical, and at the same time thoroughly practical, work, which cannot fail to raise the already high status of the series to which it belongs.

BOTANY.

Methods in Plant Histology, by C. J. Chamberlain, A.M., Edition II. (Fisher Unwin, 1906; 10s. 6d. net). The first edition of this book, written by a teacher of botany connected with the University of Chicago, was very favourably received in this country on account of its sterling merit; the present edition embodies all the reliable laboratory methods that have been discovered during the interval of four years. The collection and preservation of material, very important features, and on which further research almost entirely depends, receive special attention. Methods of growing laboratory material are also clearly outlined. The almost endless variety of reagents and stains catalogued by dealers are apt to bewilder the student, and lead to much loss of time and vexation of spirit. A careful perusal of the book under consideration will, however, clear away such difficulties, as only those materials that have proved most suitable for specific purposes are indicated. A special chapter is devoted to the comparatively new method of making permanent preparations in Venetian turpentine, which is stated to be much superior in results to the well-known glycerine method. The subjects indicated above occupy about one half of the book, the remainder being devoted to an introduction to the study of forms which, while serving for practice in microscopical technique, will also furnish the student with preparations including a general view of the structure of plants, ranging from the algae up to the angiosperms. The book will well repay the time expended on a careful perusal by every teacher of botany, however much experienced.

A Text - Book of Botany; Part I., The Anatomy of Flowering Plants, by M. Yates (Whittaker and Co.; 2s. 6d. net).—The author has obviously yet to learn what anatomy means; the only attempt to deal with anatomy in the book defines "A Medullary Sheath, consisting of spirally-shaped vessels round it." The book consists in reality of a string of attempted definitions of the various organs of plants, illustrated by what, for want of a more expressive name, must be called figures. Up to the present, botanists have been reticent when pressed for a concise definition of a cone. Here, we are told that a cone "is a dehiscent, syncarpous fruit, of a conical form, the carpels are woody, and each bears a naked seed on its inner surface, *e.g.* pine, larch." Notwithstanding the above, and many other original statements, we are informed in the preface that, "It is by no means meant to be a popular work, but is for the use of examination students, and those who wish to commence a serious study of botany," etc., etc. The one redeeming feature is the part played by the publisher.

GEOLOGY.

Geology: Earth's History, by T. C. Chamberlin and R. D. Salisbury: Vol. II., Genesis, Paleozoic; pp. 677, and index to Vol. II.; Vol. III., Mesozoic, Cenozoic; pp. 578, and index to Vols. I., II., and III. (John Murray, Albemarle Street, W.; price 21s. each net). The second and third volumes of this series have now come to hand, and the authors deserve hearty congratulation on the completion of their work. The volumes in every way maintain the excellence of the previous volume which we received. They are clearly printed, and abound in illustrations taken direct from Nature. The third volume commences with the stratigraphical geology of the Trias, and the succeeding formations are dealt with in successive chapters, terminating with the "Human or Present Period," which, in the authors' terminology, begins with the disappearance of the glacial period, so-called, although they are careful to show that even now 10 per cent. of the land-areas of North America then covered with ice still remain in a glaciated condition. How completely America has Americanised geology is shown by a number of sections which are included in the Appendix, and although wisely the old international terms for the main systems have been carefully retained, new titles for the sub-systems and minor formations have been necessary to describe local developments. It is noticed that the Oligocene is regarded as a sub-division of the Eocene, whereas in this country it has come to be regarded as clearly defined from the Eocene below or the Miocene above. With this exception the titles of the main formations remain as in the old country, although the Lower Cretaceous receives the synonym Comanchean, a title which is now coming to be well recognised at home. In reviewing the mass of information contained in the book, concentrated as it has been from many a source, one cannot but be struck by the immense amount of work which yet remains to be done in America in connection with Mesozoic formations, and hence the necessity in some cases of giving to them local names. The Glacial Period is dealt with with particular thoroughness, no less than 100 pages being devoted to it. The title is used as synonymous with Pleistocene, and although man was a witness to this period, the Human Period is regarded as a succeeding and separate period. We do not think this arrangement free from misunderstanding, and if the title were to be adopted in British classification we should like to see included in it all those strata which bear witness to man's existence. But seeing that geologists recognise the probability of his first appearance in Pliocene times, and this may in the course of time be pushed back even earlier, we would prefer that the older arrangement should remain, viz., Pleistocene and Recent as subordinate divisions of the Quaternary. However, in these matters there will always be differences of opinion, and they in no way detract from the estimation in which we regard the whole work. Insular geology must be avoided at all costs by insular geologists, and it is to be hoped that these books will soon be found in all geological libraries in our country.

PHYSICS.

Practical Physics (Bower and Satterly, University Tutorial Press; 4s. 6d.).—In this handbook, we have a series of admirably designed and explained exercises on practical physics. They are suited to matriculated students, but in many cases are such as could be performed at home. In the latter, care has been taken to make them such as can be performed at trifling cost, and yet all trivial experiments have been avoided. The language employed seems, as a rule, very concise and definite. We notice, however, the usual inconsistencies in the use of the terms weights and masses. In the instructions on weighing, the "weights" are sometimes called by that name, and are sometimes called "masses." For example, the *masses* are to be added in descending order, while the *weights* are to be replaced in the box. This looseness will undoubtedly cause confusion. On the whole, the confusion would be least if we boldly spoke of *masses* throughout, and described the process as *massing* a body. This is a small detail. We recommend the book strongly to anyone in search of a text-book.

Properties of Matter (C. J. L. Wagstaff, University Tutorial Press).—This refers to the more general properties of bodies, many of which are usually considered in a course of mechanics, and it seems to have been specially designed to suit the requirements of those who may be going in for their degree without pursuing a thorough course in mechanics. We do not wish to say anything that will encourage this, at any rate, when a student is a student of physics in the real sense. For botanists and zoologists who may be taking physics as one of their subjects, and who then wish to throw it aside, the book will no doubt prove very useful in giving a brief account of its subject. We regret to see it stated that the standard metre is the length of Borda's rod, and the kilogram is the mass of the lump of platinum, made by Borda, and kept in the Archives. These have long since been supplanted. We regret to see "whole pressure" defined without any warning that this quantity is no use. Is Reynolds' theory of matter now looked on with favour? We thought it was discredited.

THERAPEUTICS.

Unconscious Therapeutics; or The Personality of the Physician, by Alfred T. Schofield, M.D., second edition. (J. and A. Churchill; 5s. net).—The author in his new edition has made important additions to the text, and re-written Chapter VI. Dr. Schofield, in his opening chapter, "The Mind in Therapeutics," makes the interesting observation that in cases of hysteria or neuromimesis, the patient's sufferings are real. He attributes the phenomena to the power of an unconscious mind in an abnormal condition, and not, as was once taught, to an unhealthy womb. In unmistakable language he warns the profession against the folly of treating the body and forgetting the mind; he puts implicit faith in the mental personality of the physician or surgeon acting on the unconscious mind of the patient for the latter's good. To emphasise the power of mind over body, instances are given where medical men have succumbed to the very diseases which they have made their special life-study. These instances may be merely coincidences, or it may be that a certain disease was studied in particular, and dwelt upon mentally because the specialist himself was a victim to it; in any case, opinion leans to the belief that continuous concentration of thought on any one particular part of the body tends to its local malnutrition and eventual organic disease. Genius alone is of little avail unless accompanied by such necessary attributes to success as set forth by Dr. Schofield in his chapter, "The Personality of the Physician." Genius, as a matter of fact, is not an essential, for who cannot recall to memory names of many worthy and eminently successful disciples of Æscalapius, whose success in life followed from what they *were* more than from what they *knew*. There is much worldly wisdom in these pages, but let us hope that evil consequences, such as are portrayed as a possible resultant from a visit to a Harley Street consultant, are overdrawn. The plodding, careworn, weary, practitioner might scan the chapter on "The Secret of Success in Practice" with a fond hope that this secret is laid bare; he will find there apt quotations from, among others, Reynolds, Gull, and Treves, containing advice felicitously and loftily expressed, but the secret that still lies hidden defies the efforts of successful genius to define. The closing chapter chiefly consists in an exposure of quack methods and Christian Science remedies; it also eloquently pleads for the need of systematic study of "Unconscious Therapeutics" in our medical schools. That this will come in time is hardly in doubt, and when it does, the profession will be the more fully armed and equipped for war against quackery than it has been in the past. Dr. Schofield deserves the gratitude of his medical brethren for bringing this subject so prominently before them.

ZOOLOGY.

A Treatise on Zoology, edited by E. R. Lankester, Part V., Mollusca, by P. Pilseneer (London: A. and C. Black, 1906, pp. 355, illustrated).—The want of a thoroughly scientific and trustworthy work written in English on the Mollusca, which should embrace the results of continental research on this difficult but interesting group, has long been felt in this country. The want is supplied by the handsome volume before us, which is the work of Dr. Pilseneer, the greatest living authority on the group to which it is devoted. In securing such a writer the Editor is to be highly congratulated, as this has resulted in a volume which will long remain the standard on the subject. A good idea of the vast strides which have been made in our knowledge of the natural history of the group, and also of the difference between present and former methods of investigation and description, will be gained by contrasting the volume before us with Woodward's "Manual of the Mollusca," which was regarded as an excellent work in its day. The amateur must not expect that he will be able to assimilate all that is to be found in this volume, sentences like "the Mollusca are cœlomocœla with a distinct cœlom and hæmocœl," and "in the adult there are two cœlomic cavities, the pericardial cœlom and the true gonocœl or gonadial cavity" indicating that it is written by a specialist for advanced students and specialists. For these, despite the occurrence of such a forbidding name as "Prorhiphidoglossomorpha," it will doubtless prove all that is expected—and that is a great deal!

MISCELLANEOUS.

Martin's Tables, or "One Language in Commerce." By Alfred J. Martin. Fourth Edition. (London: T. Fisher Unwin, 1906, pp. 271; price 2s. 6d.)

At Kimberley last summer the reviewer was told that a truck-load of blue clay from the diamond mines contains on an average only about .4 of a carat. This statement did not convey much meaning at the time, but reference to this useful and handy book now shows that about 82 milligrams is the average yield per truck; that is 1-12th of a gram. The book serves two purposes, one to provide useful information of every kind about weights and measures generally, and the other to urge the compulsory adoption by Great Britain of the international metric system. The arguments in favour of the metric system are so well known and so forcible that there is no need to here repeat what every reasoning man knows and feels strongly about. It would not be too much to say that English conservatism in this matter is in some measurable position responsible for the back seat which England takes among the countries of the world in regard to recognition of exact science. It cannot be said that the same demand exists for a decimal coinage. Coinages of different countries are of the most varied description, but the majority possess one feature in common, namely, that their largest unit is inconveniently small for representing pounds and hundreds of pounds, and that this unit is divided into cents which are too small to conveniently represent sums expressed in pence. None of these coinages ought properly to be called decimal coinages. If the French had only adopted metric nomenclature in their coinage their case would have been a strong one. The decifranc, franc, decafranc, and hectofranc would be excellent monetary units for any country to adopt; the franc and centime are not satisfactory. Moreover, the shilling of the duodecimal system finds its way into France in the frequent occurrence of 1 fr. 25 in prices. And it must not be forgotten that if England is conservative in regard to weights and measures, English and Italian speaking people can *count* properly up to a hundred and upwards, and this is impossible in the languages of many civilised countries, *e.g.*, France and Germany.

Chance: A Comparison of Facts with the Theory of Probabilities. By Joseph Cohen (London: Charles and Edwin Leyton, pp. 48; price 2s. net).—What makes the average Britisher a gambler, both in his business and in his recreations, is his ignorance of the laws of probability. He speculates in the hopes of making a fortune, instead of devoting his attention to estimating the probability factor which often converts that fortune into an expectation of loss. It is important that some knowledge of the theory of probabilities should form a part of the most elementary education in order to check this absurd and injurious speculative tendency, and there can be no better way of making a start than by showing that the results of theory are borne out by actual experience. The author details the results of many thousands of trials made by tossing a coin and throwing dice, also with cards and Halma pieces, and he compares the numbers obtained by actual trial with those found by theory. The result gives an interesting idea of the percentage divergence which is to be anticipated when the number of trials is finite, and it is interesting to see how this divergence is small in the case of the more probable events, and becomes greater in the case of improbable ones. The book can be read by anyone, and requires no knowledge of mathematics.

The Anatomy of Knowledge: an Essay in Objective Logic, by C. E. Hooper (London: Watts and Co., 1906; pp. 226, price 3s. 6d. net). The appearance of this excellent and thoughtful little work is opportune, for, as the author observes, it can scarcely be denied that many of our modern specialists and experts are in the position of persons who cannot see the wood for the trees, or, as it may be more aptly expressed, who cannot see the tree for the branch on which each happens to be sitting. *Quo vadis?* is, indeed, applicable to a large proportion of the scientific workers of the present day, and anything that tends to consolidate thought on the object and trend of the vast stores of knowledge that are now being accumulated, and as to the nature of knowledge itself, should accordingly receive a hearty welcome by all thinking minds. What is knowledge, what are the principal things of which we have knowledge, how do we know what we do now, what is the relation of knowledge to practical life, and how is it connected with religious belief? are some of the fundamental questions the author endeavours to answer. Although philosophy, which is really the subject of this work, is a study often supposed to be abstruse and unpractical, "it may yet prove to be the very fulcrum by means of which the power of enlightened human will is destined to effect a renovation of the world." The application of philosophical methods to endeavour to ascertain to what (if any) goal many of our scientific studies are leading us, is a crying and urgent necessity.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Royal Microscopical Society.

May 16, Dr. Dukinfield H. Scott, President, in the chair. Dr. Bernstein gave an account of some observations recently made on the parasites of malaria, and the phagocytic action of the polymorphonuclear leucocytes. The subject was illustrated by a large number of drawings on the blackboard, showing the result of examinations made at intervals of a few minutes during a period of five hours, upon the blood of a patient suffering from malarial fever. A crescent form of the parasite was seen to become engulfed by a leucocyte, in which it was soon surrounded by vacuoles and ultimately destroyed, only the pigment granules remaining, which were themselves afterwards approached, and absorbed by other leucocytes. The blood film was stained, and the preparation, showing the pigment granules in the polymorphonuclear leucocytes was exhibited under a microscope at the meeting. Mr. C. Beck exhibited and described a simple wave-length spectrometer, for the purpose of testing colour screens, designed by Mr. E. M. Nelson, in conjunction with Mr. J. W. Gordon. It consisted of a diffraction grating, a slit, a collimating lens, and an eye lens. Mr. Gordon had worked out a method of measuring wave-lengths by this instrument without any reference to tables, as shown by a diagram exhibited, the wave-lengths being read off in millionths of an inch. The President then referred to the annual exhibition of pond life, in giving which, the Fellows had been greatly assisted by Members of the Quekett Microscopical Club. Nearly 40 microscopes were upon the tables.

Quekett Microscopical Club.

On May 18, Mr. A. E. Smith gave an account of the three methods he employed in stereo-photomicrography. In the first described, an arrangement similar to a Waterhouse diaphragm, in a photographic lens, is fitted above the objective, the aperture being eccentric to the optical axis of the microscope. Photographs are taken first with the aperture on one side of the axis, and then with the aperture on the opposite side of the axis. In the second method, which is very effective, the object is tilted up on the right and on the left respectively, for the two photographs. The third method was to first photograph the object in the usual way, and then to shift it laterally, very slightly, of course, before taking the second photograph. A number of excellent stereograms obtained as above described were exhibited.

Mr. D. J. Scourfield, F.R.M.S., gave an account of "Mendel's Law, and its Relation to Microscopy." Mendel's work was done in 1865, but was lost sight of until 1900. Details of some of his experiments were given, and his success in framing a law of heredity was attributed to his method of fixing his attention upon pairs of characters without troubling about the hybrid as a whole. Mendel's law stated shortly, is that, when the germ-cells of hybrids are formed, half of them contain the factor for one of each pair of characters, and the other half the factor for the other character. This generalisation accounts not only for the facts brought forward by Mendel, but also for a very large range of additional cases recently investigated. After dealing with the relation of Mendelism to microscopy, and the possible utilisation of microscopic organisms, such as the *Entomostraca*, for experimental work, attention was directed to the necessity for the modification of certain current views on "pure" races, variation, and the origin of species, which follow the acceptance of Mendel's law.

Quekett Club Journal.

The half-yearly, April issue of the Journal of the Quekett Club contains several interesting papers which have been read before the Club, and briefly reported in "KNOWLEDGE." Amongst these is an account of Mr. E. J. Spitta's experiments on the compound eyes of insects, which lead him to suggest that the facets of the cornea are in reality nothing but minute holes, filled, possibly, with some non-refractive material, and forming in the eye what is known as "pin hole images," which may consequently be well defined. The Journal also contains Mr. Spitta's Presidential Address on "The Relative Merits of the Long and Short Tube Microscopes," which, with the subsequent discussion, is, however, somewhat inconclusive; full particulars of Mr. Dollman's and Mr. Taverner's respective methods of making stereo-photo micrographs, with some excellent plates illustrating results; and other papers. The notices of new books again find a place in the Journal.

Injection for Fine Vessels.

P. Konasck0 successfully and easily injects the organs of small animals by the following procedure: When it is desired to inject, say, the portal system of the kidney of the frog, a canula is introduced into the vena cava inferior or the vena abdominalis anterior. These large vessels are then injected with warm, colourless gelatine. The organ is, of course, placed in a water bath during the injection. When the operation is completed, the preparation is removed and allowed to cool. It is now easy to insert a canula into the finer vessels, which are distended by the injection-mass. When the canula is fastened, the preparation is placed in warm water again. After an immersion of a few minutes, the gelatine is liquified, and then the injection-mass is easily syringed in.

Flagella of Tubercle Bacillus.

Mr. E. M. Nelson, who is well-known as one of our most experienced and careful microscopists, and who first demonstrated the beaded, or, as he now calls it, jointed, appearances of the stained tubercle bacillus in the same year as its discovery by Dr. Koch, namely, in 1882, has recently stated that he has observed this bacillus to be flagellated. In view of the generally accepted opinion that this bacillus is non-motile, confirmatory evidence of this observation is necessary, but Mr. Nelson's skill and experience, and above all, his caution, make the statement one that must be received with respect. Mr. Nelson states that he has observed bacilli with single flagella, and others, with a flagellum visible at each end. He gives the uncorrected length of the bacillus as $2{\cdot}94\mu$ long, and $\cdot34\mu$ broad, and the length of the flagellum as $1{\cdot}24\mu$.

At a recent meeting of the Royal Microscopical Society, Dr. Hebb read the following further communication from Mr. Nelson, which will interest many microscopists:—"It may interest you to hear that the flagella of the tubercle bacillus can be seen with a dry lens. The apochromatic 4 m.m. (long tube), by Zeiss, and the 7a (short tube), by Leitz, both will demonstrate the flagellum. There is nothing of particular interest in this of itself, but there is one point worth noting, which is, that it is only the bacilli stained with fuchsin that will shine on a dark ground; other objects in the field, such as nuclei stained blue, hardly show up at all upon a dark ground. Therefore, if the flagellum was, as has been said, some other object stained blue and lying fortuitously against the bacillus, it never would have been seen upon a dark ground. The image is necessarily a difficult one, even shining as it does with the fuchsin in it, but unless it was an integral part of the bacillus, and took the stain with it, it would be perfectly invisible."

In reference to the remarks made above as to the beaded appearance of tubercle bacillus, Mr. Nelson calls attention to the fact that improved methods of staining show the unit cell to be square ended, the apparent distance between one cell and the next is much reduced, and the whole bacillus looks something like a jointed bamboo; the resolution of these joints has become proportionately more difficult, and can no longer be performed by quite low powers.

As branching forms of this organism have been seen by other observers, as well as clubbed and swollen shapes, and gland-like clusters in experimentally affected animals, the evidence seems to be accumulating that *Bacillus tuberculosis* should not be included amongst the monomorphous bacteria, and does not represent a single bacillus, but belongs rather to fungi of the nature of actinomyces, and that the name "tubercle fungus," would be in the meantime preferable.

New Form of "Erlich" Eyepiece.

Messrs. R. and J. Beck, Ltd., have brought out a new form of "Erlich" eyepiece for counting blood corpuscles. It is of the standard students' size (R.M.S. No. 1 gauge), and is provided with a square aperture which is adjustable by means of an external and graduated wheel, and can be varied from 1 mm. to 8 mm., so that it can be instantly set to the most convenient size. The actual area to which the size in use corresponds when used with any particular object-glass is ascertained by slipping a stage-micrometer on the stage of the microscope.

New Oil Immersion Objective.

Messrs. A. E. Staley and Co., have sent me, for examination, a new 1-16th inch homogeneous immersion objective, with a numerical aperture of 1·3, made by the Bausch and Lomb Optical Co. The use of a lens of this magnification is limited, as it is an axiom of modern microscopy, that resolution is dependent upon aperture and not on mere empty magnification, but given a certain aperture, and consequently a proportionate resolving power—that is, for example, an ability to resolve a certain number of lines to the inch—it still is necessary for these lines to be magnified sufficiently to enable the human eye to distinguish them. It is here that the personal factors come in. Some observers have keener vision than others, either by nature or by training, and I have myself found that the average observer needs an object to be magnified to a point possibly beyond that of best definition if he is to see it to his satisfaction. But most objectives will not stand really high eye-piece magnification, and the higher the power of the objective, the less will they bear a high eye-piece. It is therefore sometimes advantageous to obtain a given magnification by increasing the power of the objective, and contenting oneself with a lower eye-piece, and many workers find an objective of moderately increased power, such as a 1-16th inch, easier to work with on difficult objects than a 1-12th inch of the same aperture, and equal theoretical resolving power. Of the lens under notice, I can speak highly. Its definition is excellent, and its working distance ample. I have tested it on some difficult spirilla, as well as in more theoretical ways, and was much pleased with its performance.

Microscopical Material.

By the kindness of Mr. Edwin R. Gill, of Poole, I am able to offer to such of my readers as care to apply for it some specimens of *Drosera* (Sun-dew). Applications must be accompanied by a *stamped and addressed envelope*, and by the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

Notes and Queries.

Floatings of Foraminifera.—Mr. F. Mockler, of Bath, will be glad if any reader can tell him where he can get some floatings of Foraminifera, which will give him some *Nodosaria* and *Dentalina*.

Staining Yeast Nuclei (B. C. H., Bradford).—Yeast nuclei are very difficult to stain, and to see when stained. They must be first fixed with weak Flemming's solution, and then stained with such nuclei stains as saffronin, orange G, or gentian violet. The first of these stains is perhaps the best, though it takes rather longer than the others. Before staining, the fixing solution must be washed out by irrigation methods, and after staining irrigated in a similar way with alcohol and oil of cloves.

Volcanic Dust from Mont Pelee Eruption.—Mr. W. A. Rogerson, of Longsight, writes in reply to the enquiry of the Rev. W. Hamilton Gordon: "I have a little volcanic dust from Vesuvius, collected on a steamship, in the Bay of Naples, on the deck of which it lay an inch deep. A little of this dust was mixed with benzole, and well shaken upon settling. A slide was arranged with a drop of benzole solution of Canada balsam, a little of the dust from the benzole washing was then put into this drop of Canada balsam and well stirred with a needle; a cover glass, with the lower surface smeared with Canada balsam was then lowered on the dust, and the whole slide left to dry on the oven. The mounted slide should be examined with polarized light, when the particles of contained silica show up very clearly."

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for July.

By PROF. A. FOWLER, F.R.A.S., and
W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.48 and sets at 8.18; on the 31st he rises at 4.23 and sets at 7.49. On the 3rd, at 7 a.m. the earth is at its greatest distance from the sun, the solar parallax then reaching its minimum value of 8″·66.

Notwithstanding the declining solar activity, sun-spots and solar prominences are still fairly numerous. Eruptive, or metallic, prominences, however, have lately been of somewhat rare occurrence.

There is a partial eclipse of the Sun on the 21st, but no part of the phenomena will be visible in this country, the favoured regions being the South Atlantic, the Falkland Islands, and S. Patagonia. At the maximum phase about one-third of the Sun's disc will be obscured.

The positions of the Sun's axis and equator, and the heliographic longitude of the centre of the disc, are shown in the following table:—

Date.		Axis inclined from N. point	Centre of disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
June 30	..	3° 32′ W	2° 55′ N	59 54′
July 5	..	1° 0′ W	3° 27′ N	353 44′
„ 10	..	1° 17′ E	3° 58′ N	287 33′
„ 15	..	3° 33′ E	4 28′ N	221 24′
„ 20	..	5 45′ E	4° 55′ N	155 12′
„ 25	..	7 55′ E	5° 21′ N	89 4′
„ 30	..	9 59 E	5° 44′ N	22 56′

THE MOON:—

Date.		Phases	H. M
July 6	..	○ Full Moon	4 27 a m
„ 13	..	☾ Last Quarter	10 13 a.m
„ 21	..	● New Moon	0 59 p.m.
„ 28	..	First Quarter	7 56 p.m.
„ 4	..	Perigee	11 18 a m.
„ 16	..	Apogee	0 6 p m.

OCCULTATIONS.—The following occultation is visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.
July 2	γ Librae	4 1	p.m. 7.55	73	p.m. 8.52	329

THE PLANETS.—Mercury (July 1, R.A. 8^h 14^m; Dec. N. 21° 27′. July 31, R.A. 9^h 47^m; Dec. N. 9° 9′) is an evening star throughout the month, reaching its greatest easterly elongation of 26° 39′ on the 15th. On the 1st he sets at 9.43, on the 13th at 9.22, and on the 25th at 8.35 p.m., but in consequence of the long twilight is not favourably placed for naked eye observation. The planet is stationary on the 26th.

Venus (July 1, R.A. 9^h 3^m; Dec. N. 18° 41′; July 31, R.A. 11^h 17^m; Dec. N. 5° 35′) is an evening star, and is a conspicuous object in the western sky after sunset. On the 1st she sets at 10.14 p.m., and on the 31st at 9.16 p.m. The apparent diameter increases from 13″·2 to 15″·8 during the month. Telescopic examination will show that the planet is gibbous, about three-quarters of the disc being illuminated. The planet is in conjunction with the crescent moon on the 24th at 7 p.m., the planet then being 1° 23′ to the south of the Moon.

Mars is not observable this month, being in conjunction with the Sun on the 15th.

Jupiter (July 1, R.A. 5^h 32^m; Dec. N. 22° 56′; July 31, R.A. 6^h 0^m; Dec. N. 23° 8′) is a morning star throughout the month, rising at 2.46 a.m. on the 1st, and at 1.14 a.m. on the 31st. He will be found in the eastern part of Taurus.

Saturn (July 1, R.A. 23^h 8^m; Dec. S. 7° 39′; July 31, R.A. 23^h 4^m; Dec. S. 8° 8′) is coming into a more favourable position for observation, rising at 11.7 p.m. on the 1st and at 9.31 p.m. on the 31st. He is describing a retrograde path in Aquarius. The apparent axes of the outer ring at the middle of the month are respectively 43″ and 2″·6, while the polar diameter of the ball is 17″. The northern surface of the ring is presented to the earth.

Uranus (July 16, R.A. 18^h 25^m; Dec. S. 23° 28′) is rather low in our latitudes, but is otherwise well placed for observation. The planet is in Sagittarius and rises at about 7 p.m. near the middle of the month, and then crosses the meridian at 10.50 p.m.; it will be then about three quarters of a degree east, and nearly two degrees north of λ Sagittarii (mag. 2·9). Its remarkable spectrum of broad dark bands is well worth the attention of observers, even though possessing only small instruments.

Neptune is not observable this month, being in conjunction with the Sun on the 2nd.

METEOR SHOWER.—The most notable shower in July is that of the δ Aquarids, which occurs on the 28th. The radiant is situated in R.A. 22 h. 6 m., Dec. S. 11°, and the meteors are slow with long trails.

TELESCOPIC OBJECTS (double stars, &c.):—5 Serpentis, XV.^{h} 13^m, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.^{h} 41^m, N 15° 44′, mags, 3·8, 10; separation, 31″.

θ Serpentis XVIII.^{h} 51^m, N. 4° 4′, mags. 4·0, 4·2: separation, 21″·6. Both are yellow, the primary being paler than the smaller star.

ξ Cephei XXII.^{h} 1^m, N. 64° 8′, mags. 4·7, 7; separation, 6″.

δ Cephei XXII^h 26^m, N 57° 56, mag. 4·2, 7: separation 40″. A pretty pair for small telescopes, stars respectively yellow and blue. It is also a typical short period variable star, not of the Algol type, the period being 5^d 9^h, with a sharp rise from minimum to maximum in 1^d 9^h. There will be minimum on the 2nd at 3 a.m., from which succeeding minima and maxima may be calculated by the intervals given.

Cluster in Libra, M 5. A compact cluster situated about one-third of a degree north of the double star 5 Serpentis; it appears like a large nebulous star when viewed with a pair of opera glasses.

Cluster in Serpens, N.G.C. 6633: about one-third of the way from θ Serpentis to α Ophiuchi. The cluster is visible to the naked eye.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

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Cloud Photography.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

WHO has not sat on the grass or a bench on a hot summer's afternoon and turned his head skywards and watched the ever-restless clouds wafted along by the aerial currents?

Who, also, has not had his attention drawn to a towering cumulus cloud mounting up and up into the higher regions of the atmosphere and preparing itself for a possible exhibition of atmospheric electricity, in the form of a thunderstorm?

Latent energy, grace, beauty, to say nothing of the exquisite gradations of shade, are all present in those masses of water-vapour or ice-crystals, and it is really surprising what little attention they receive, even at the hands of the photographer, except possibly for an occasional casual remark.

To the meteorologist of to-day the study of clouds has assumed an important part of his work, for by their movements and changes of form, the inner workings of the upper air currents can be, to a certain extent, watched. This must be so for a long time to come, as the employment of kites and *ballon-sondes* does not yet allow us to reach at short notice such elevated regions; clouds are therefore the only means we have for nearly continuous observation at great altitudes.

The part played by the photographer is to record, for later study if necessary, the forms and types of cloud The camera thus affords the means of making a classification of clouds more complete than was previously the case, in addition to presenting us with a most interesting pastime.

One decided advantage of cloud photography over many other photographic pieces of work, is that it can be pursued wherever the photographer happens to be. Clouds we have nearly always with us, and sometimes we think much too often, and the upper storey or roof of a house, failing a better position, affords an excellent place to work from.

One of the first cloud classifications was put forward by Luke Howard in 1803, and up to quite recently this has held first place. Many other attempts in the meantime have been made at a more scientific classification, and most, if not all of them, with the exception of that of Clement Ley, were simply makeshifts. Ley's classification is undoubtedly long, and is not well fitted for use except by professional investigators or those amateurs who wish to take up the subject of nephology thoroughly, and have plenty of time at their disposal. During more recent years, an attempt has been made to draw up a more simple and efficient system and that which is now being adopted is termed the "International System of Cloud Nomenclature."

There is, however, quite a large literature on cloud classification and cloud photography, but it is not my intention to pass this in review in this article. It may, however, serve a useful purpose to draw the reader's attention to several publications on this subject, if he should wish to dip more deeply into this interesting study.

The "International Cloud Atlas," to which reference has just been made, has text in English, French, and German, and is published by Gauthier Villars, in Paris (1896). The Hydrographic Office at Washington has published (1897) an atlas illustrative of cloud forms which includes 16 coloured plates.

Quite recently, Mr. A. W. Clayden has published a valuable contribution in his book on "Cloud Studies" (John Murray, London, 1905), and this contains a great number of photographic reproductions from his negatives.

In this Journal numerous illustrated articles have appeared from time to time on the progress of cloud photography. Thus, for instance, E. M. Antoniadi (Vol. XIV., p. 202 and Vol. XV., pp. 79 and 107); James Quicke (Vol. XIV., p. 103); Wilson Barker (Vol. XVII., p. 104); and H. C. Russell (August, 1894), have all contributed much information, which should be consulted by the photographer.

Other valuable contributions to cloud literature include "Instructions for Observing Clouds," by the Hon. Ralph Abercromby (London, 1888); "The Cloud World" (Elliot Stock, London, 1903), by Samuel Barker; "La Photographie et l'étude des Nuages" (Mendel, Paris, 1898), by Jacques Bayer; and several works and articles by Hildebrandson, Koppen, Newmeyer, Clement Ley, Angot, Tisserenc de Bord, Flammarion, &c.

The above references will, no doubt, serve to draw the reader's attention to some of the work that has been accomplished, and he will soon be able to extend this list for himself when he becomes better acquainted with the subject.

For the purpose of this article, only the two main classes into which clouds may be divided need be mentioned. The first is the "cumulus" form of cloud, which is formed by *vertical* convection, that is, the air is transported from one level to another. The second main class is the "stratus" cloud, which is generally the result of the flowing of two currents of air over each other, the temperatures being different in the adjacent layers.

The former type indicates an attempt to restore

1

4

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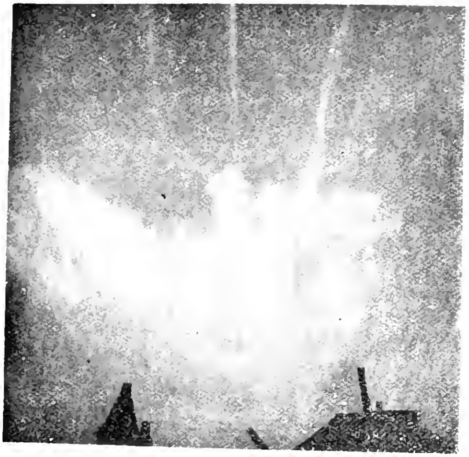
PLATE I.



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equilibrium in the vertical direction, while the latter shows a similar effort in the horizontal direction. It is the interaction of these primary processes in greater or less degree which is responsible for the several intermediate types of clouds.

The existence of cloud at any elevation tells us that the atmosphere in that particular part is in a state of saturation, and that the vapour is being condensed. The form of the cloud also indicates to us the conditions under which this air space became saturated with the consequent formation of cloud, and hence shows, to some extent, changes which are in progress in the upper air which may affect the weather at the earth's surface. The direction of motion of the cloud finally gives us a good clue to the winds which are blowing high up in the air.

While the eye can be devoted to note the direction, the camera should be employed to record the form.

In cloud photography, the great desideratum is to produce contrast and secure clear, well-defined negatives with brilliant high lights. The predominance of blue rays in reflected skylight is in many cases a great drawback, since the photographic action of blue is almost identical with that of white light. It becomes therefore, almost a necessity to quench the blue of the sky while preserving the light of the clouds. The whole art of successful cloud photography lies in overcoming this difficulty. The ways of doing this are many, and the efficiency of the different methods employed varies to a great degree.

One of these methods includes the use of a diaphragm, a quick exposure, and an after intensification of the negative. A more efficient method seems to be the employment of a coloured screen in front of the objective, the exposure of the plate necessarily depending on the colour and density of the glass or liquid employed. In fact, there are many variables involved, not forgetting the speed of the plate itself. Even when the exposure has been made the question of development arises. Some, in fact most, authorities advise a fairly weak solution with a slow methodical development.

Many workers prefer to rely on backed slow plates, a full exposure and a properly restrained developer. Mr. Clayden, to whom reference has above been made, photographs his clouds by reflection from a black mirror placed just in front of his object glass; he employs slow plates, namely, photo-mechanical, and by this process he obtains results which, as he says, are "uniformly and continuously successful."

From the above remarks it will be seen that there are many ways and means of photographing clouds, and very much depends on the operator.

My own experience of the subject is very limited, in fact, my attention was only attracted specially to the subject during April of the present year. I may, however, preface the following description of the method I employ by saying that my object was not necessarily to obtain pictorial photographs, but negatives which would bring out well the forms and changes of both dense and very thin clouds. In fact, I have not yet gone to the length of using a wide angle lens, so necessary for including a large field, as my intention up to the present has been to try and secure satisfactory photographs. The photographs which accompany this article will serve to show some examples of various kinds of clouds, which are representatives of types of photographs, all of which are obtained without any difficulty. The camera which I use (see Fig. 1) is a small 5 by 4 instrument, made by Winkel, of Gottingen, Germany, and is fitted with a Zeiss lens of 4.4 inches focal length, and 0.75 inches aperture. I usually work the diaphragm shutter, giving an exposure of about one-twentieth of a second, with the lens cut down to about *f* 8.

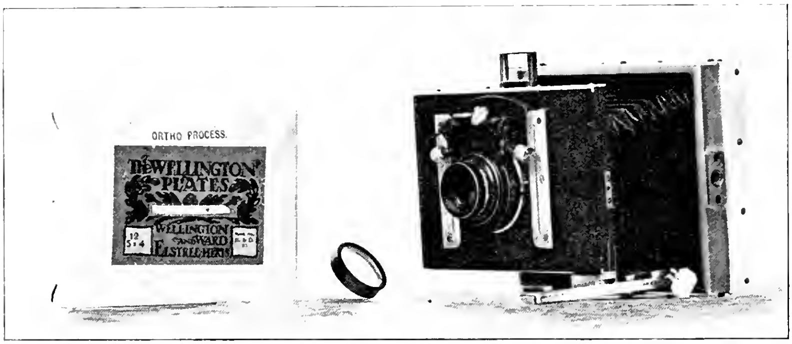


Fig. 1.—Cloud Photographic Equipment.

Fixed on the front of the lens is a Kodak glass yellow screen, which increases a normal exposure tenfold. Although I have not used many different kinds of plates, I find that the ortho-process plates of Messrs. Wellington and Ward (Elstree, Herts), with speed number H and D 80, give very satisfactory results, so satisfactory, in fact, that I have not looked further afield.

Regarding development, I am no advocate of the slow process, and prefer the negative to be fully developed in about five minutes. The actual solutions I employ are given below, and equal quantities of each are used; sometimes three or four plates are developed with the same five ounces of developer.

HYDROQUINONE DEVELOPER (MAWSON).

No. 1 SOLUTION.

Hydroquinone	320 grs
Bromide of Potassium	320 ,,
Metabisulphite of Soda	320 ,,
Water (distilled)	80 ozs.

No. 2 SOLUTION.

Caustic Soda	600 grs.
Water (distilled)	80 ozs

The camera is always held in the hand, and pointed in a direction which, as a rule, is well away from that of the sun.

If the reader examines the two plates of photographs he will see that good details are given both in the heavy cumuli (Plate I., Figs. 1, 2, and 3), and in the light, fleecy clouds (Plate 1, Figs. 4 and 5, and Plate 2, Figs. 1, 4, and 5). It may be considered that the contrast between the blue sky and cloud, in some of the illustrations, such as Plate 1, Fig. 2, is too strong; from a pictorial point of view, this is possibly true, but from the cloud-form standpoint, I do not think it is excessive.

Very interesting is the photograph in Plate 2, Fig. 5 On the occasion on which this plate was exposed, there were cross currents in the upper air, and the apparent mingling of the clouds formed a striking object. In the same plate (Fig. 3) the photograph illustrates an overcast sky, with low clouds travelling quickly from north-east. Fig. 1, also in Plate 2, is a good illustration of clouds being drawn out by the action of a faster moving current of air. The form known as "mare's tails," is well shown in Plate 1, Fig. 4, while Fig. 5 of the same plate, is typical of "mackerel sky."

Most of these photographs were secured during spare moments, generally between 1 and 2 o'clock, p.m., so that the best positions or conditions of the clouds could not always be chosen. The fact also that they were taken at South Kensington indicates further that the London photographer need not necessarily go far afield to find his subjects.

The Dipping Refractometer.

WE have received from Messrs. Carl Zeiss a description of their latest form of dipping refractometer, together with a bibliography of papers in scientific literature dealing with the subject. The dividing line between physics and chemistry is being gradually broken down, and we are beginning to trace a relationship between chemical constitution and physical characteristics. The determination of many physical data has become of recognised value in chemical analysis, and this is notably the case with the refractive index, which is of considerable use as a rapid sorting test, especially in the analysis of oils and fats. The firm of Zeiss has made a special instrument, known as the butyro-refractometer, for this purpose, and this is in common use in laboratories all over the world. The dipping refractometer, which is intended for the examination of liquids in general, is not so well known, though in many instances it will give immediate results as accurate as those given by chemical methods. The prism and plate are formed from one piece of glass, which is to be immersed in the given liquid, and the degree of the refraction of the light can then be read on the scale by means of the telescope. The refraction is proportional to the amount of the substance in the solution, and it is thus possible, with the aid of special tables, to make rapid determinations of, say, the amount of alcohol in spirit, albumen in blood serum, sugar in extracts, or to determine the strength of solutions of various salts in water.

The San Francisco Earthquake.

A COMMISSION to consider the Californian earthquake was appointed three days after its occurrence, and with the same American promptness has already presented its preliminary report. From it we gather that the area of destructive effects extended over four hundred and fifty square miles of territory, and was distributed on either side of a great rift extending for a distance of some hundred and eighty-five miles. Along the hundred and eighty-five miles of this rift, where movement has actually been observed, the displacement has been chiefly horizontal, and the country S.W. of the rift has moved to the N.W. relatively to the country on the other side of the rift. The amount of dislocation varies in the neighbourhood of the rift. Sometimes it is not more than six feet, sometimes as much as sixteen feet; eight or ten feet is the average. There was also a slight vertical movement amounting in some places along the rift

Signature of the San Francisco Earthquake,
Written by means of the seismograph at Oakland, California.

to four feet. It is the great length of the rift which makes the earthquake unique. Within the area of destructive effects the intensity varied greatly. It was greatest on the rift line. Water-pipes, conduits, and bridges crossing the line were rent asunder; trees were uprooted and cast to the ground in great numbers, and others were split from the roots up; some were snapped off short. Buildings were usually wrecked, but some escaped with slight damage. Fissures opened in the earth and closed again, and in one case a cow was engulfed. The places which suffered most, like San José, Stanford University (seven miles from the rift), are those which are underlain to a great extent by loose geological formations. It is suggested that the origin of disturbance lay at a considerable depth. A curious fact mentioned, however, by a correspondent of the *Scientific American* is that in the Almadan quicksilver mines of San José, 1,500 feet deep, the workmen did not feel the shock, though the buildings at the mouth of the mine were shaken down.

The New Asteroid 1906 TG.

By Dr. Giorgio Abetti.

Amongst the numerous asteroids which the photographic researches of Prof. Max Wolf and his co-workers at the Konigstuhl Observatory, Heidelberg, are continually adding to the long list of those already discovered, there is a faint one of the 13th magnitude which, by reason of its very small diurnal orbital motion of about $\mu = 300''$, or nearly that of Jupiter* himself, is of particular interest to astronomers.

The new asteroid, provisionally known as 1906 TG, has, as seen from the earth, a slow retrograde motion—as is usually the case with asteroids when discovered near their opposition to the earth—parallel to, and a little south of, the ecliptic, which has given rise to the conjecture that of all the bodies of this class hitherto known this may be found to be the most distant. It was photographed anew at Konigstuhl on March 3, and two days later it was observed visually at Vienna by Prof. Palisa, who followed it until April 22, when it had fallen to the 14.5 magnitude and changed from retrograde to direct motion.

Basing his data on the two first observations, viz., February 22 and March 5, Prof. Berberich was enabled to calculate an approximate *circular* orbit which at once revealed the small value of μ, or, in other words, the great distance of the asteroid from the sun. According to this first calculation the period of revolution came out as 11.37 years, which, in comparison with the 11.86 year period of Jupiter, was thus seen to be only half a year shorter; but as further observations became available, Prof. Berberich succeeded in deducing the following elliptic orbit :—

Epoch 1906, February 22 5 Berlin M.T.

M	—	48°	57′	23″.6	
ω		120	25	50.0	1906.0
Ω		315	34	6.8	1906.0
i		10	20	53.0	1906.0
φ		9	38	42.6	
μ				295″.133	
log. a				0.719993	

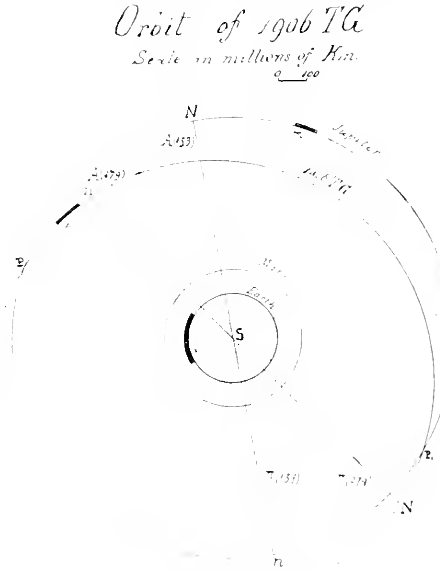
This orbit must obviously not be taken as final, for of the entire path of 360°, but one sixtieth, corresponding to the observed motion through 6° in two months, has so far been observed.

In this second calculation the period of revolution, as given by $\mu = 295.133$, comes out as 12.03 years, or almost two months greater than that of Jupiter, and it is evident that, when still further and more accurate orbital elements deduced from later observations have become available, the period of revolution may be found to be equal or even slightly less than that of Jupiter.

In any case the fact is now placed beyond dispute that there is a great resemblance in the revolutionary periods of the two bodies, or, if it is preferred, in their mean distances from the sun; for that of Jupiter is 5.20 r, or 5.20 times the radius of the earth's orbit, while that of TG (corresponding to log. $a = 0.72$) is 5.25 r.

Now the distance of Jupiter, which has only a slightly eccentric orbit, is subject to but a small variation; the distance of TG, however, oscillates between 4.37 and 6.13, and as r, the radius of the earth's orbit, is equal to 150 million kilometres, it follows that the distance of the new asteroid from the sun can vary between 655 and 920 millions of kilometres. Its orbital eccentricity, moreover, is four times that of Jupiter, so that, bearing in mind the fact that the sun occupies one and the same focus in all the planetary orbits (all more or less elliptical), TG in each revolution about the sun pursues a path which is for about 5 years *within* and for about 7 years *without* the orbit of Jupiter.

If, as in the figure, we describe circles about a centre S, representing the sun, a better idea will be obtained of the orbit of the new asteroid with respect to the orbits of Jupiter, Mars, and the Earth, all projected on



the plane of the latter, *i.e.*, the plane of the ecliptic. The portions of TG's orbit lying outside and inside the path of Jupiter are indicated by dotted and continuous lines, while the points N and n represent the ascending and descending nodes respectively of the orbits of Jupiter and TG on the ecliptic. From February 22 to April 22, 1906, the three bodies, Jupiter, TG, and the Earth, had described the paths indicated by the short, heavy lines. At the present time, TG is moving faster than Jupiter, and, while continuing to recede from him, will shortly pass a point P, which, in the figure, represents the inter-section of the orbits as seen projected upon the ecliptic.

Taking the small difference in the sidereal revolutions of the two planets for granted, it is easy to see that an actual approach of the two bodies could only take place in the course of centuries; indeed, from a recent observation made by Prof. Palisa on May 22, it would appear that the mean diurnal motion given above is somewhat too small. A larger value would have made the resemblance between the sidereal revolutions still

* The diurnal orbital motions of the major planets are :

Planet.				μ, or diurnal orbital motion.		
Mercury	..	..	..	14732″	=	245′.5
Venus	..	..	..	5768″	=	96′.1
Earth	..	..	..	3548″	=	59′.1
Mars	..	..	..	1887″	=	31′.5
Jupiter	..	..	..	299″	=	5′.0
Saturn	..	..	..	120″	=	2′.0

greater. For the present, however, and for a considerable time to come, the great attractive force of Jupiter will be unable to alter in any essential particular the present path of TG. At the points P and P[1], of the two actual orbits, that of the asteroid lies 0.5 terrestrial radii respectively below or above the Jovian orbit and, having regard to the eccentricity of TG, which, as noted above, is four times that of Jupiter, it is improbable that the two planets can ever approach each other much nearer. In round numbers it has been calculated that their distance can never be less than 70 millions of kilometres.

Should this approach, however, take place, it would in all probability persist for an indefinite period, for through the agency of Jupiter, whose volume exceeds that of TG perhaps 30 million times, the orbit in question would be very materially modified.*

Hitherto the most distant asteroids known have been:—

(153)	Hilda at a mean distance from sun equal to	3.95 r
(279)	Thule ,, ,,	4.27 r
(361)	Bononia ,, ,,	3.95 r
(499)	Venusia ,, ,,	3.92 r

Of these it is considered that Thule alone could make an appreciable approach to TG, namely at intervals of about 36 years, and to within a distance of 0.07 r, or 10 millions of kilometres.

In the figure the aphelion and perihelion points of (153) Hilda, and (279) Thule, are indicated in A and π respectively.

The diameter of TG is estimated to be from $\frac{1}{30}$ to $\frac{1}{20}$ of the radius of the earth, *i.e.*, from 200 to 300 kilometres, which, for an asteroid is, after all, not so small a value when it is borne in mind that the diameters range from 800 for (4) Vesta, or 700 for (1) Ceres, down to 14 and 10 for (228) Agatha and (452). . . . It is difficult, however, in the present state of our knowledge to arrive at a more accurate estimate of the planet's brightness, one of the factors on which are founded the determinations for the diameter, as the results so far obtained show some discordance, and it is quite possible that in this case, as in others, we have to deal with a variability in intrinsic brightness.

As with the discovery of (433) Eros, eight years ago, the orbit of Mars ceased to form the inner boundary of the asteroidal zone, so in the present case the discovery of TG deprives the Jovian orbit of the privilege of representing its outer limit; and here an interesting consideration suggests itself, for had this important discovery, which thus enlarges the region assigned to the asteroids, been made at a time when TG happened to be in conjunction with Jupiter, it might have been thought for the moment that astronomy had succeeded in adding an eighth member to the Jovian system.

Certain it is, however, that with every advance in our optical means, be they visual or photographic, new surprises are sure to present themselves within our solar system.

* In No. 4094 of the *Astronomische Nachrichten* (May 31st) Prof Charlier, director of the Lund Observatory, maintains, on the strength of his well-known analytic researches, that in the actual position of TG we have an ostensible proof of a problem divined by Lagrange—the problem, namely, of the three equidistant bodies in an equilateral triangle; or the problem of the perturbations caused by two large masses, the sun and Jupiter, on an infinitesimal mass such as TG, for which problem, he maintains, a definite and final solution can be found. For as the orbits of Jupiter and TG are practically equal, the radii vectores of the planets must be similarly conditioned, and as the elements of Prof. Berberich give to TG an elongation from Jupiter equal to about 60°, which, by reason of the equality in motion, will be permanently maintained, it is clear that the equilateral triangle in question actually subsists in this case, thus offering new and interesting data for future research in celestial mechanics.

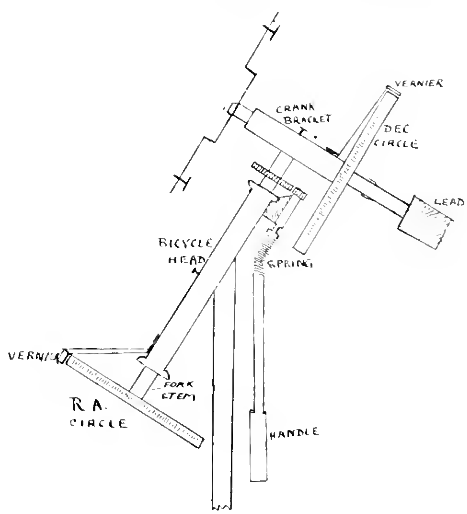
A Cheap Equatorial for Small Telescopes.

By E. W. Pollard, B.Sc.

Many possessors of a 3-in. astronomical telescope feel they cannot go to the extent of buying an equatorial head, which may be priced at anything from ten guineas. And yet they know little real work can be done without one. The majority of double stars are never found, and bright planets, like Venus, are frequently near the sun, so that by the time they are visible to the naked eye their image is spoilt by atmospheric refraction and glare.

The writer, feeling this difficulty, has constructed an equatorial from an old bicycle and a few oddments usually found in a jobber's collection; the details of construction may be useful to readers of "Knowledge."

To form the main support, one of the cross bars of a "diamond" frame is cut off; the ball head is cleared



of all attachments, and the front wheel forks cut off at the base; the handles similarly cut from the handle-bar tube. The centre of the "head" is brazed to the main support at the polar angle; any cycle repairer will do this, and for his guidance a card is cut showing the colatitude angle (about 38°).

The crank bracket is also cleared of attachments, and brazed to the end of the handle-bar tube before-mentioned; this must be done at exactly right angles, and may, perhaps, tax the cycle repairer's patience.

At the free end of the crank spindle a thread is cut to take an ordinary bicycle screw, and a piece of steel to hold the telescope, bent as figured, is fixed on, being secured in position by solder around the threads.

Over the other end of the spindle, which bears the cogged driving wheel, a tube is fixed, carrying at its distal end a lump of lead to balance the telescope.

To make the graduated circles, long brass strips, about $\frac{1}{2}$ in. wide, are procured. The right ascension circle is made from a strip of 576 mm. long; this can be divided with a metre rule, each 5 minutes of the circle equalling 2 mm. The result will be a convenient circle having a diameter of about 7 inches. The engraving is easily done with a pointed penknife and ruler, and the markings blackened with solution of antimony chloride (butter of antimony). The figures are preferably in plain English numerals, these being more easily read than Roman. The numbering should be anti-clockwise, from right to left, as it will be the circle that rotates.

Having turned this to a true circle and soldered the ends, a strip is soldered across, forming a diameter, and the centre of this is soldered to the end of the fork stem as shown.

The declination circle is made from a brass strip 720 mm. long, each degree equalling 2 mm. If the cogged wheel of the bicycle is 9 ins. in diameter, a usual size, it will be found that with a little filing of the cogs the strip will exactly go round, and may be fixed in position by soldering at each cog.

Verniers are fitted to both circles as shown; pieces of brass 18 mm. long are divided into 10 equal parts; the R.A. vernier will thus read to 30 secs. and the declination vernier to 6 mins. Thumb-screws are made to clamp in R.A. and declination.

A slow motion in R.A. is a great advantage, and a simple device is to put a cogged wheel (from a clock or similar contrivance) around the handle-bar tube; this can be driven by a smaller cogged wheel fixed to the head; a handle is made by soldering a brass rod to a spiral brake spring, and this to the small wheel. As the telescope rotates on ball bearings comparatively little strength in this slow motion is needed, and the spiral spring, while allowing the handle to be used in any position, does not "give" unduly.

Finally the main support can be let through a mahogany block on a tripod stand, and adjusted to any height, or permanently fixed by cementing it into a large drain-pipe set on a concrete base. Or it can be fitted to a more elaborate stand with levelling screws and artistic masonry.

With regard to the performance of the instrument, that will depend on the care with which it is made and adjusted; there is no reason why any star should not be in the field of view with a low power eyepiece, provided calculations are made from some book, such as the "Science Year-Book," which should be found in every astronomer's library.

As to the cost, an old bicycle can be bought for a few shillings; doing all the work but brazing and thread cutting, the cost to the writer was under half-a-guinea.

The adjustment will probably take some time, and difficulties will be surely encountered, but by the time the amateur has overcome these he will have a very fair knowledge of the "Motion of the Heavens."

Attention is directed to the growth of camphorism, or the habitual use of camphor internally, among the Slovaks of Upper Hungary, by Dr. Aba Sztankay, in *Honte Lapok*, a Hungarian political journal. Dr. Sztankay has kept an eye on the camphor-consumers for the past fourteen years, asking each purchaser of the drug to what use he was going to put it, and he does not think he exaggerates when he states that fully 25 per cent. of the whole amount of the drug sold is used by the camphor-eaters. That the estimate of the quantity of the gum used in this manner must be very considerably increased, is shown by the fact that grocers and other dealers, beside apothecaries and druggists, handle the article. The Slovaks of the region observed by the author are subject to frequent attacks of epilepsy, and this he thinks stands in some relation to the habit alluded to, an opinion that is fortified by the fact which he was enabled to verify, that the administration of camphor was followed by epileptoid convulsions.

Studies in Cohesion.

By Dr. Alfred Gradenwitz.

The recent work of Professor St. Leduc, of Nantes, constitutes a considerable advance towards an explanation of certain phenomena characteristic of the life of cells, that is, of the constituents of all vegetable and animal organisms. Though the enigma of the origin of life is hereby in no way solved (nor can a real solution be expected from a continuation of these researches), the mechanism of the phenomena has been explained to a certain extent. The important part played by *diffusion* in connection with all life phenomena of cells has been more especially ascertained, showing the possibility of accounting for the life of living matter, at least as to its external aspect, from a purely physical point of view. These results have recently been completed by experiments showing the no less important part to be ascribed to the force of cohesion. In fact, many phenomena which formerly did not allow of any explanation may now be readily accounted for on physical laws.

By inserting drops of a solution in a differently concentrated solution of the same substance, Leduc has already, a few years ago, constituted artificial cells, the diffusion of the liquid resulting in structures which were entirely analogous in their behaviour to natural cells, and which were exclusively controlled by the laws of diffusion. Now these liquid structures, so far from remaining unaltered, were recently found to undergo a transformation which was not to be explained by the laws of diffusion. In fact, the structures then produced were wholly independent of the distribution of osmotical pressure. If the evolution of the structure be allowed to continue, motions just opposite to those originally produced under the influence of diffusion would be observed, although the direction of forces remained unaltered.

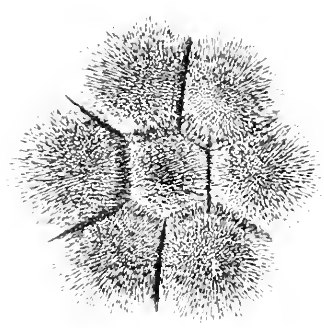


Fig. 1.

If a solution of potassium nitrate be spread out on a glass plate and drops of the same solution, but of smaller concentration, coloured with Chinese ink, be introduced in the former, these drops, owing to the differences in pressure, will be found to diffuse and to result in the liquid structure represented in Fig. 1.

After seemingly remaining unaltered for 5-10 minutes, these continue their evolution. In fact, the carbon particles contained in the Chinese ink, and which at first, owing to diffusion, had left the centre of each of the drops, will go back again in the original direction, tending to combine in the centre of the drops,

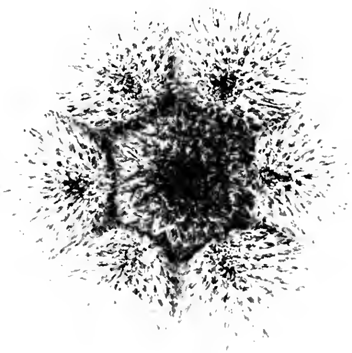


Fig. 2.

while small groups of particles accumulating at the same time in the lines of direction will form ever-increasing grains (Fig. 2), which travel towards the centre of the drops (Fig. 3). If evolution be allowed to continue, the Chinese ink will thus be found to combine in a liquid hectagonal ring, and finally in a homo-

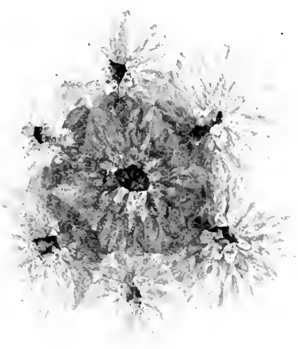


Fig. 3.

geneous mass. A similar drop, as represented in Fig. 4, in natural size, had the dimensions of an ordinary drop (of no more than 3 mm. diameter) on being introduced into the solution, but afterwards, owing to diffusion, reached a diameter considerably higher than that of the photograph, thus assuming the shape of a negative field of diffusion. The drop is afterwards retracted into itself, its centre becoming darker and darker, while its lines of force are separated into ever-increasing grains approaching towards each other and towards the centre of the drop, until they take the aspect represented in Fig. 4.

While not being explained by the action of diffusion, these phenomena are fully accounted for on that of cohesion. In a liquid like the present potassium nitrate solution, containing a microscopical powder such as the carbon particles of the Chinese ink in suspension, the following forces of attraction should, in fact, be considered : (1) The cohesion between the molecules of the solution; (2) that between the particles in suspension, and (3) the mutual attraction between the floating particles and the molecules of solution. An equilibrium will be produced if these forces be strictly equal to each other, which will only exceptionally be the case. Whenever the forces of attraction are, however, unequal, no equilibrium will be obtained unless there is a perfect symmetry round each of the molecules of solution and each floating particle. So far from being stable, such an equilibrium will be discontinued whenever the perfect symmetry ceases. If, *e.g.*, the attraction between the floating particles be considerably stronger than that acting between these

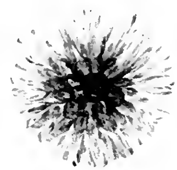


Fig. 4.

and the particles of solution, any accumulation resulting in a disturbance of symmetry will constitute a centre of attraction for other particles, which, by joining the former, will increase their force of attraction. The part incumbent on diffusion now is a double one; it first counteracts the realisation of symmetry in the liquid, setting solid particles and liquid molecules in motion; on the other hand, it carries them into the range of centres of attraction where they come under the sway of cohesion. This is evidently what occurs in the present experiments.

Professor Leduc has, moreover, been able immediately to demonstrate this explanation experimentally by preparing a solution of potassium nitrate coloured with Chinese ink of so precisely the same osmotical pressure as a transparent solution of the same substance, that the coloured drops not penetrating by diffusion into the transparent solution did not undergo any alteration. If, however, the same drops were introduced close to each other, they were found to alter their shape and to be lengthened towards each other, approaching one another, and eventually combining into a sphere. Whenever drops of different dimensions are introduced at equal distances (Fig. 5), the largest drops, exerting a prevalent attraction, will incorporate the small ones. Leduc thus observed (Fig. 5) six small drops arranged around a big one, which, after altering their shape, began travelling towards the larger one. This in turn altered its shape, and under the influence of the attraction of the six small drops assumed the form of a hexagon, the least pronounced angle being situated in front of the farthest distant drop.

Now the foregoing effects of cohesion, which had so far been unknown, seem to play a pre-eminent part in connection with certain physiological phenomena. The segmentation of the vitellus (yolk of eggs) during incubation, had, *e.g.*, so far been one of the most enigmatical phenomena of animal life, there being no known physical force under the influence of which a similar effect might have been produced. Now the conditions of incubation are quite similar to those obtained in the present experiment, the high temperature resulting at the surface of the egg in a vaporisation, which, in the surface portion of the yolk, produces a concentration.

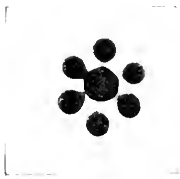


Fig. 5.

Thus currents of liquid (due to diffusion) arise, which in turn, as in the above experiment, must result in a subdivision or segmentation of the mass. The artificial segmentation obtained by Leduc (Fig. 6) will be found to be strikingly similar in appearance to the natural segmentation of the yolk.

Now all lamellar and vacuolary structures in living

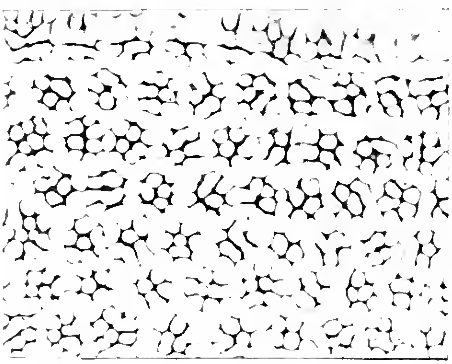


Fig. 6.

organisms are made up of may be obtained in a similar way. Protoplasm in turn consists of the same structures, while those artificially obtained by Leduc show phenomena quite analogous to the lamellar, cellular, and vacuolary structures of living protoplasms. These are retractile, their cohesion increasing in retraction in quite the same way as that of coagulating colloids. In fact, real colloids seem, in the experiments at issue, to be obtainable from solutions of crystallinic substances. This would constitute another transition stage between categories hitherto distinct, while explaining and artificially reproducing the physical mechanism of coagulation. Cells and lamellar structures obtained in

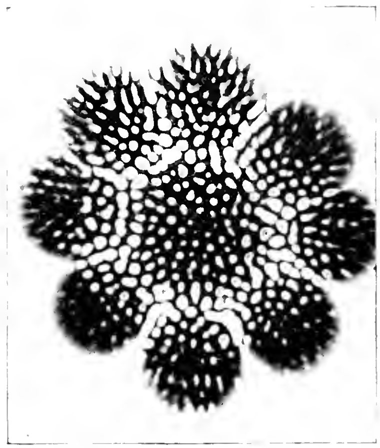


Fig. 7.

virtue of diffusion and cohesion, by the aid of such solutions and in microscopical powder therein suspended, are represented in Figs. 7 and 8.

The same phenomenon would, moreover, afford a

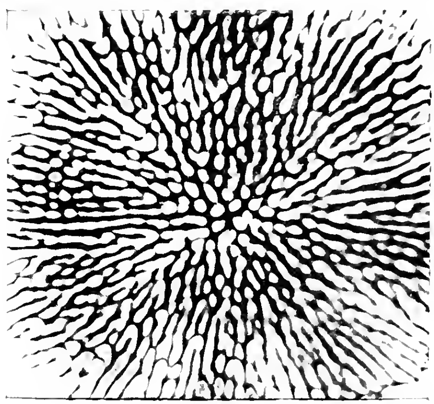


Fig. 8.

physical explanation of the much-discussed phenomenon of flocculation in turbid liquids.

As, finally, the conditions of Leduc's experiments are realised also in natural water, and especially in sea water, in which foreign particles are always in suspension, producing currents of diffusion due to their dissolution, the external agreement in the shape and behaviour of natural organisms and protoplasms on one hand and the artificial structures obtained by Leduc on the other would be fully accounted for.

British Association at York.

Programme and Prospects.

This year's meeting of the British Association assembles under the happiest auspices at York. No place, unless it be a University, is more in harmony with the conduct and spirit of the British Association than a cathedral town, and in none is the hospitality of a more graceful kind. It is twenty-five years since the British Association met at York, there to celebrate its jubilee; and this accident of chronology affords a ready opportunity for a Presidential Address to summarise the work of the past quarter of a century. In Professor E. Ray Lankester, Director of the British

PROFESSOR RAY LANKESTER.

Museum of Natural History, the Association possesses a President whose ability is peculiarly adapted to the task. Professor Ray Lankester is the one British zoologist of genius, and the one authority to whom the work of other men can be referred for critical examination and appreciation. His insight and knowledge fit him to appraise, as his example has fitted him to inspire, the best work of his time and generation in England. Such tributes are tacitly or openly expressed by all those workers in zoology—and in the allied sciences which that substantive includes—whose own work has the merit of insight and originality. But Professor Ray Lankester is more than that to his generation. He is one of the men of science, by no means large in number, who are articulate, whose utterances are coherent in the ears of the multitude, and who is, in the broadest sense, a critic of scientific education and scientific progress. Few men of science in speaking of subjects which are of interest, or which ought to be of interest, to all thinking people, have been responsible for more noteworthy utterances; and few have laboured more—with very little popular comprehension or recognition to encourage them—to advance the cause of science in the nation. It is not customary to disclose any of the particulars of the Presidential Address before its delivery, but it is violating no confidence to say that Professor Ray Lankester's Presidential Address on Wednesday, August 1, will reflect both his critical and proselytising activities; and besides summarising a quarter of a century's progress in science, will deal with the national neglect of science in the schools, by the Government, and in commerce.

The President of the Mathematical and Physical Science Section is Principal E. H. Griffiths, of the University of Wales, much of whose work has been associated with the relation of the units of heat and work. His address will deal, among other subjects, with the present position of the theory of the constitution of the earth's interior, as that theory has been modified by the discovery of radio-active substances.

Besides the papers to be read in this section, which include one by Sir W. Ramsay on chemical and electrical changes induced by ultra-violet light, and one by the Earl of Berkeley on osmotic pressure, there are to be several discussions. Professor Soddy will open one on the evolution of the elements; Mr. J. Swinburne and Dr. H. Rubens, of Charlottenburg, will discuss the radiation from incandescent mantles; and the Hon. R. J. Strutt and Professor J. Milne will speak of the internal structure of the earth. A discussion is also to be opened on the re-measurement of the British geodetic arc.

Professor Wyndham Dunstan is the President of the Chemical Section, and in his address will speak on the necessity for establishing a Central Government Department to deal with the problems of chemistry. Such a department could and would play a most important part in effecting the commercial development of the Colonies, and in regulating and developing the products of the Empire.

Mr. E. W. Lamplugh is the President of the Geological Section, and will open up, no doubt for subsequent discussion, the question of "Interglacial Periods." Professor J. W. Gregory will deal with the palæozoic glaciations of Australia and South Africa, and Professor J. Milne will contribute notes on recent earthquakes. Many papers on Yorkshire geology are a natural consequence of the place of meeting.

Mr. J. J. Lister, F.R.S., is the President of the Zoological Section, and in this section the burning questions of heredity can scarcely fail to be discussed. The subject, however, is not very prominent in the list of papers submitted to the recorders of the section, and the chief subject of general interest appears to be that of the relation of scientific marine investigations in relation to fishery problems.

Sir George Taubman Goldie takes the Presidential chair in the Section of Geography, and will speak on the growth of modern interest in geography. The following papers are promised:—The scientific results of the Scottish Loch Survey, James Murray; The Chagos Islands, Indian Ocean, J. Stanley Gardiner; A Journey across the Sahara, M. E. F. Gautier (not quite certain); The Structure of Southern Nigeria, John Parkinson; The Study of Social Geography, Professor G. W. Hoke, of Ohio State Normal College; A Journey in the Central Himalayas, T. G. Longstaff.

Professor J. A. Ewing, as President of the Engineering Section, will deal with the probable molecular condition of metals when in a state of strain; and papers on practical engineering subjects, such as Standardisation (Sir J. Wolfe Barry), Glow Lamps (Sir W. Preece), Monophase Electric Traction (C. F. Jenkin), Turbines (C. G. Storey), Waterproof Roads and Dust (Douglas Mackenzie), will be read.

Mr. Sidney Hartland will deal in his Presidential Address to the Anthropological Section with the growing interest in anthropology and the growing recognition of its practical importance by the colonising nations and races. A discussion will take place in the section on early British skulls, and Dr. C. S. Myers will contribute a paper on measurements in the Egyptian Army. Dr. Haddon will speak on South African ethnology; Professor Ridgeway on the origin of the fiddle; Professor Flinders Petrie on Egyptian discoveries in 1906; and there are various papers on Anglo-Roman and Anglo-Saxon remains.

Professor Gotch's address to the Physiologists is one of the most important contributions to controversy during recent years, and states very frankly his position with regard to the subject of "vitalism" in physiological science. It is the most arresting statement of opinion since Dr. Japp's address on the "Nature of Life" some years ago at the Bristol meeting. A discussion is to be opened in this section on the physiological value of rest, and another on minimum diet values. The Chemical Section will co-operate in this discussion.

Professor F. W. Oliver, Quain Professor of Botany at University College, London,.will deliver the address to the Botanical Section, taking for his subject "The Seed, as a chapter in Evolution." Three topics have been chosen by the section for discussion:—(1) Some aspects of the present position of Palæozoic botany will be dealt with by Dr. D. H. Scott, F.R.S., and the conditions of growth of Carboniferous plants by Professor F. E. Weiss and Miss M. C. Stopes. (2) The nature of fertilisation and kindred problems, at a joint session with Section D (Zoology). (3) The phylogenetic value of the vascular system of seedlings. Mr. A. G. Tansley and Miss E. N. Thomas will open the proceedings, while Professor Jeffrey, of Harvard, Messrs. A. W. Hill, T. G. Hill, and Miss Ethel Sargant are expected to contribute by papers or otherwise to the discussion.

Professor Michael E. Sadler will deliver the Sectional Address on Education, and the proceedings of the section will be rich in discussions on "Health in Schools," the "Curriculum of Primary Schools," and "The Teaching of Modern Languages."

Mr. A. L. Bowley will preside over the Section of Economics and Statistical Science, and will take for the subject of his address the importance of true scientific method in statistical research.

MR. CHESTER TENNANT, of Dawson, in the Yukon, furnishes us with some curious particulars on the things that happen when the mercury in the Fahrenheit thermometer goes to 60 deg. or 70 deg. below freezing. The steel of edged tools becomes so brittle that it will break almost as readily as glass under sudden strain or shock; spikes of nails used in the wooden-built houses contract; coal oil begins to thicken and solidify till it assumes the consistency of lard; and a lighted lamp left out in the cold goes out in about an hour because of this reason. Every stovepipe in the township throws out a great cloud of steam and vapour, and a consequent white grey mist, or haze, remains permanent in the atmosphere, so that there is always a sort of frozen fog in the day time. Even people exhale this fog, like locomotives, and the breath roars out like a mild jet of steam.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Ozobrome.—This curious word is derived from "ozone" and "bromine," though it indicates a process with which ozone has nothing to do, and bromine very little. It is a method recently patented by Mr. Thomas Manly (who, a few years ago, introduced the ozotype process), by which a bromide print is made to furnish one or several carbon prints. This means that the facility of making a bromide print either by contact or enlarging methods, necessitating only a few seconds' exposure to artificial light, may be combined with the advantages of carbon or pigment prints with their permanency and the wide choice of colours that they permit. Indeed, the new method presents notable advantages as compared with the ordinary carbon process, for not only is daylight unnecessary for the exposure, but the print is not laterally reversed though there is no double transfer, and in one modification no transfer at all. The principles involved are very simple. The bromide print consists of a metallic silver image in a gelatine film. Silver is in many cases a very efficient reducer, and by bringing into contact with it a pigmented gelatine film sensitised with a bichromate, the silver, directly or indirectly, reduces the chromate, much as exposure to light would, to a chromium compound which renders the gelatine insoluble.

The practical details run on the following lines: A bromide print, which may be an old one, but must have been thoroughly washed, is soaked in a formaline solution for a few minutes to harden the gelatine, and washed. The carbon tissue or "pigment plaster" that is to be used is soaked till limp in a solution that contains an alkaline bichromate, ferricyanide, and bromide, while the bromide print is soaked in water, and the two squeegeed together. If one print only is required, after a few minutes the print is plunged into hot water and developed in the same manner as a single transfer carbon print. But if desired, the same bromide print will furnish several carbon prints, by plunging the original with the carbon tissue squeegeed to it into cold water, separating them gently, and then treating the carbon tissue exactly as if it had been just exposed to light in ordinary carbon printing. The short contact with the original is equivalent to the otherwise necessary, and often prolonged, exposure to daylight under the negative. The silver of the bromide print is changed into a silver salt, but immersion in an ordinary developing solution reduces it to the metallic state, and so it can be used over and over again. It seems that all carbon tissue is not suitable, and that a specially soluble kind is supplied by the patentee. Full working details will probably be obtainable before this is published, together with modifications and other applications of the process.

This process seems, on the face of it, to have so much to commend it that the essential difference between it and carbon printing by the ordinary methods must not be lost sight of. Carbon printing, as hitherto practised, is a printing-out process, and the charm of a carbon transparency, as well as its reliability for reproduction purposes, lies largely in this fact. Probably no method gives a more exact representation of the negative, for the possibilities of altering the gradation by accident or design are hardly worth consideration. But in the "ozobrome" methods, the result depends upon development in the same sense in which the negative is developed, and while this may sometimes be an advantage to the skilled worker, it renders all sorts of errors possible. This radical difference must ever be borne in mind.

Specially Sensitised Plates.—Since my notes of two months ago were printed, I have received from Messrs. Wratten and Wainwright samples of their specially sensitised plates. There are four kinds, all essentially different from the ordinary "isochromatic" plates, in being so much more sensitive to red, and therefore to yellow, that yellow colour screens, that generally need the exposure to be increased to ten times, with these plates require only about a doubled exposure. The "verichrome" plate may be developed in a deep red light, but no light is safe for the others, except that a very weak green light might be used with the pinacyanol-bathed plates. These last are extraordinarily sensitive to red. The pinachrome-bathed plates are very sensitive to red, but less than the pinacyanol plates, and they are more sensitive to green. Without doubt, the most useful for general purposes are the "verichrome" plates, for moderate red sensitiveness, and the "panchromatic" plates, if extreme red sensitiveness is wanted, and as these are not called bathed plates, I presume that the emulsion is sensitised before the plates are coated. The plates are all of high general sensitiveness, the H and D figure ranging between 100 and 200, and they all give good gradation. Each box contains a card that gives the sensitiveness on the H and D, Watkin's and Wynne's systems, the time required for development at 50°, 65°, and 80° F., besides other information.

Received.—Messrs. Taylor, Taylor and Hobson have sent me a flexible releasing arrangement, on the Bowden wire principle, for the shutter referred to last month. It is of excellent design and workmanship, and is attached to or removed from the shutter in a moment by a bayonet joint. Such releases are much to be preferred to pneumatic balls, because they have no indiarubber in them to perish, and they give a positive rather than an elastic push. I have so far found only one disadvantage, namely, that if a comparatively short bend is necessary, as may be in some hand cameras, it will cause too much friction in a Bowden wire before it interferes in any way with the flow of air through a tube.

The "Imperial Handbook for 1906," is chiefly a collection of useful hints and data for those who use photographic materials. It includes a price list of the Company's manufactures, and the recommended formulæ for their treatment.

The "Photo-Miniature" for last December, price 6d., is just to hand. It is a useful little volume on bromide printing and enlarging.

Vitality of Seeds.

To the disputed question of the vitality of dried or buried seeds a new contribution has been made by M. Fliche, a French botanist. In the Forest of Hane some years ago he was astonished to find large quantities of a plant called cypress-spurge, or wolf's milk, in blossom. It is a plant well known in Italy, but not indigenous to France. Two years later the plants entirely disappeared. Similarly another growth, in another clearing of the forest, was unearthed, and this in its turn flourished and disappeared. The obvious botanical reason for the disappearance of a plant is that it is choked in the struggle for life by the existence or overgrowth of other plants better suited by the environment; and that the cypress-spurge, not finding itself able to cope with its surroundings, disappeared.

NOTES

ASTRONOMICAL.

By Charles P. Butler, A.R.C.Sc. (Lond.), F.R.P.S.

Origin of Lunar Formations.

In the annual report of the Paris Observatory for 1905 M. Loewy briefly discusses the results of a very thorough investigation of the lunar photographs which have been obtained with the great equatorial Coudé, in preparation of the 9th volume of the Atlas Photographique de la Lune. Endeavouring to find possible causes of the peculiar formations of seas and mountains, three distinct sources are tabulated :—(*a*) They may be due to meteor swarms circulating round the sun; (*b*) projections from terrestrial volcanoes; (*c*) they may have been detached from the earth while still fluid, and have circulated round in orbits only slightly differing from that of the moon. Examining these in detail, the first two are found to be incapable of explaining the known phenomena, and it is concluded that the third suggestion is the more probable, the annexation of the ring of satellites at intervals, while the surface of the moon was sufficiently condensed to enable the masses to become attached without being entirely absorbed and their individual forms eliminated.

Return of Finlay's Comet.

Following close on the publication of the Search Ephemeris by M. L. Schulhof, we have the announcement of the rediscovery of Finlay's comet, under conditions which promise to permit of more favourable observations than during its previous apparition in 1886. Perihelion passage is computed to take place on September 7·5, and the brightness of the comet on June 18 about twice as bright as when discovered in 1886, its brilliancy probably steadily increasing up to the end of August.

The announcement of its re-discovery at Koenigstuhl was made by telegram, giving the following position :—

	h.	m.		
R.A. =	23	38·3		(1906. July 16 13 14·4 Koenigstuhl M.T.) (d. h. m.)
Decl.	−14	3′	(S)	

The object is travelling in a north-easterly direction, and is described only as bright.

Report of Observations of Total Solar Eclipse, August 30, 1905.

The reports of observations made by members of the British Astronomical Association of the total solar eclipse of August 30, 1905, have now been issued together in a most attractive and interesting volume, covering almost all sections of eclipse investigation. The main expedition was stationed at Burgos, under the direction of Mr. C. Thwaites, the duration of totality being about 3m. 45s. The sun remained covered with clouds up to within 15 seconds of totality, when suddenly a rift appeared, through which the eclipse was observed. The corona was seen of a pearly white colour, not so bright nor with so long streamers as the corona of 1898. It was, in fact, a typical sun-spot maximum corona. Numerous drawings of the corona are given as seen at various stations along the line of totality, and a reproduction of a beautiful photograph taken by the Rev. A. L. Cortie at Vinaroz with a 4-inch objective of 19 ft. 4 ins. focal length, fed with light from a 8-inch coelostat mirror.

Especially interesting on account of the meagre spectroscopic results obtained by the more powerful equipments of the unfortunate expeditions is a reproduction of a very clear spectrogram of the flash spectrum taken by Mr. E. Dickson at Burgos. This was taken with a fixed half-plate camera of 15 ins. extension fitted with a single Wray lens and a Thorp replica grating; it shows the chromospheric spectrum in excellent focus from Hβ to the extreme ultra-violet.

Objective Prism Comparison Spectrograph

Various suggestions have been made in recent years for the utilisation of the large light grasping power of objective prism spectrographs in radial motion determinations, the chief difficulty being in the production of a suitable comparison spectrum owing to the absence of a slit. Mr. De Lisle Stewart proposes to employ two prismatic cameras mounted together, with their axes inclined, say, about 15° to each other. These will give two spectra close together on the photographic plate, but in reverse order. Two smaller lenses of equal or greater focal length than the main objectives would be placed in the central line of the apparatus, one to serve as guiding telescope and the other to photograph a reference image or trail of the star on the plate. By placing the two prisms in these positions it is hoped to avoid many of the flexure difficulties hitherto encountered in this work.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Air that Extinguished Flame.

IT was recently noticed in a cold storage that candles or lamps began to burn with a feeble flame as soon as they were brought into the room, and that in many parts of it they were extinguished. A match could be lit, but the wax would not ignite. In the corner of the storeroom was a disused well, from which gas issued, and Mr. Bertram Blount, who was asked to investigate the cause of the trouble, at first supposed that carbon dioxide was being distributed into the air from this well. But this was not borne out by analyses of the air in the room and from the well, for the amount of carbon dioxide was only slightly more than is present in normal air, and was quite insufficient to have affected the combustion of a candle. Samples of air taken from different parts of the room contained only 17.5 to 17.7 per cent. of oxygen, or from 3.2 to 3.4 per cent. less than is present in normal air. The oxygen in the air in the shaft of the well amounted to no more than 8.6 to 8.9 per cent., and other experiments confirmed the conclusion that the air in the storeroom was ordinary air containing less than its proper proportion of oxygen, owing to admixture with air deprived of its oxygen, which issued from the well shaft. The source of the impoverished air from the well was finally traced to tunnelling operations close by, in which compressed air was being used. This air must have found its way through the soil wherever it was sufficiently porous, and so into the shaft of the well, and on its passage through the soil must have been deprived of part of its oxygen by contact with some substance such as pyrites. Evidence in support of the correctness of this conclusion was furnished by the analysis of the mud from another well shaft near the first. This mud was found to contain pyrites, and air left in contact with it for some weeks was deprived of almost the whole of its oxygen.

Bologna Phosphorus

In 1760, Canton made the discovery that when oyster shells were calcined with sulphur in a crucible at a red heat, there was produced a phosphorescent substance, which he regarded as a form of phosphorus, but which was really an impure calcium sulphide. The so-called "Bologna phosphorus" thus obtained has found a commercial use as the luminous basis of phosphorescent paints. The luminosity does not appear to be due to a slow process of oxidation, since it has been found that a preparation that had been sealed up in an air-tight tube for a century still phosphoresced. Zinc sulphide has the same property of being luminous in the dark. It has recently been observed by Signor Vanino that the phosphorescent sulphides of calcium or zinc can act upon a photographic plate in the dark through a layer of black paper, but that all action is checked by placing celluloid between the substance and the sensitive film. Since radio-active preparations of lead can act readily through celluloid, it would seem that the action of the phosphorescent sulphides on the plate is not due to β or γ radiations (which can pass through celluloid), but to traces of sulphuretted hydrogen, given off by the sulphides, being capable of penetrating the paper, but not the celluloid. Signor Vanino also finds that the presence of calcium fluoride enables one to obtain an actively phosphorescing sulphide at a much lower temperature than is commonly used. The preparation may also contain a large amount of inert substance, and only a small proportion of calcium sulphide, and yet be very luminous.

The Identification of Horse-Flesh.

One of the most difficult problems that the chemist is called upon to solve is the identification of horse-flesh in sausages or other flesh foods. It is well known that enormous quantities of horse-flesh are eaten, chiefly in the form of sausages, on the Continent, but in England the strong prejudice against its use, the heavy penalty for selling it without a notification, and the fact that there is a ready sale abroad for broken-down horses, all tend to render its use in English sausages unusual. Apart from the specific serum test ("KNOWLEDGE & SCIENTIFIC NEWS," Vol. II., p. 86), which has not as yet come into general use, there are practically only two methods of chemical examination, the determination of the characteristics of the fat and the detection and estimation of glycogen or animal starch. The fat of the horse is of a much more oily nature than the fat of other domestic animals, and being composed of more highly unsaturated glycerides, is capable of combining with more iodine. But, although an examination of the fat, especially of that deposited between the muscular fibres, is fairly conclusive in the case of pure horse-flesh, it is unsatisfactory for mixtures, and more reliance is usually placed on the glycogen test. Glycogen is identical in chemical composition with ordinary potato starch or wheat starch, but, unlike them, gives a red instead of the well-known blue colouration with iodine. It is found in the liver and blood of many animals, and may amount to as much as 1.5 per cent. in the muscular fibre of the horse. It is also present in the flesh of the mule, but not to any extent in that of the ass. Herr Martin, who has recently published the results of his experiments, finds that any trace of glycogen in beef, veal, pork, or mutton soon disappears from the flesh, whereas in the case of horse-flesh and the flesh of fœtal animals, it can be detected and estimated for days after the animal was slaughtered. He attributes the greater stability of glycogen in horse-flesh to the blood of the horse having only a slight fermentative action as compared with the blood of the ox or sheep. Herr Niebel, some years ago, came to the conclusion that the reaction with iodine was uncertain, for he found that glycogen was also present in the flesh of dogs, cats, and very young calves, in the livers of cattle, and in meat extract. Herr Bujard, again, found that the amount of glycogen and its distribution through the body of the horse was influenced by the food given to the animal, and by its state of health, and considered that results obtained by this and similar methods should only be regarded as a confirmatory test. Another drawback is that the glycogen is destroyed by smoking the flesh, and that the presence of ordinary starch masks the red colouration that glycogen gives with iodine.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Enchanted Mesa.

IN the Journal of the Franklin Institute for June, there is an extremely interesting paper by Professor Oscar Carter, on the Plateau Country of the South-West, where is found what is known as the Enchanted Mesa. The mesa is not now inhabited, although sufficient evidence has been adduced to show that at one time, at any rate earlier than 1540, it was occupied by the Pueblo Indians, whose cliff city of Acoma is some three miles distant, and is built on a mesa, with precipitous sides. The grassy trough in which the mesas occur is a wide canyon-like valley, more than ten miles long, by two to four miles wide, and it is itself surrounded by vertical walls. This valley has been carved out by erosion into curious and bizarre forms. The strata of the plateau, by the dissection of which the mesas have been left high and dry, consist of variegated layers of sandstone, shale, and limestone, "of Palæozoic and Mesozoic ages," and lie as a rule with but a slight dip. The plateau itself is from 4,000 feet to 8,000 feet above tide, and the mesa rises precipitously from the flat plain, which forms the canyon-like valley, to a height of 430 feet from the middle of the plain. The name of the Garden of the Gods has been poetically applied to the valley, and undoubtedly it is of immense interest from the archæological as well as from the geological point of view.

New Fossil Walrus.

In the *American Journal of Science*, for June, a magazine which was founded by Benjamin Silliman, as far back as 1818, we note a description of a new genus and species of walrus founded on a left mandibular ramus, which was discovered by a student of the John Hopkins University, Mr. W. E. Curley, on a beach, at Yorktown, Va., a Tertiary littoral deposit. It has been named *Prorosmarus alleni*.

Diplodocus.

Mr. W. J. Holland has described in "The Osteology of Diplodocus Marshii" the additional material which has been collected since Hatcher's account was first published. He also gives an account of the restoration of *Diplodocus* recently presented to the British Museum. He includes a detailed description of the atlas, sternal plates, and the bone supposed to be the clavicle. The dorsal, sacral, and caudal vertebræ, and the chevrons, are also included in the description.

Some London Borings.

The varying depths under London at which the chalk has been tapped in deep wells is shown by some recently-made borings, conducted by Messrs. C. Isler and Co. At Kentish Town (Prince of Wales Road Baths) there was 124 feet of London clay, 46 feet of Woolwich and Oldhaven beds, and 34½ feet of Thanet sands, above the chalk, which was reached at 205½ feet. At the Baltic Exchange, E.C., the chalk was found at 211 feet, there being 112 feet of London clay, 42 feet of Woolwich and Oldhaven beds, and 57 feet of Thanet sands and basement beds. In the Woolwich beds there is included a thickness of 20 feet of "black rock." This, probably, represents the coaly or lignitic layer which is sometimes found in the series. The thickness is, however, unusual. At Upper Clapton (Lea Valley Works), the chalk was met at 120 feet, but across the river, at Camberwell (Warner Road), the chalk had sunk to 163 feet, whilst eastward therefrom it rose again to 134 feet at Church Street, and to 135 feet in the Old Kent Road. This is in accordance with the well-known rise of the chalk at the inner south-eastern corner of London, whilst at the extreme opposite corner the chalk, already noted at Kentish Town as at 205½ feet, sinks still further at Willesden Junction (Acton Lane), to 340 feet. At the last mentioned place the chalk was pierced, and attained a thickness of 580½ feet, the gault being bored to the extent of 80½ feet, with no intervening upper greensand. The total depth bored was 1,000½ feet, and the well must be considered one of London's deeper wells.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Black-Footed Penguin Breeding in Confinement.

The small rookery of black-footed penguins, *Spheniscus demersus*, recently established in the gardens of the Zoological Society of London, is thriving; so much so, that a pair have just succeeded in hatching out two nestlings, while another pair have made a crude nest of sticks, but so far no eggs have been laid.

The eggs of the first pair were laid at intervals of three days, the first being laid on May 24, the second on the 27th. Incubation lasted five weeks, and did not begin until the second egg was laid. The site selected for a nursery was a shelf of rock about half way up the cliff of the sea-lions' pond; while the second pair have chosen a place much lower down, and in a cave-like recess, thus more nearly resembling the burrow in which these birds usually build.

The work of incubation was undertaken by both parents, and both share in the work of feeding the young, a task which is performed by inserting the bill within that of the nestling, a method exactly opposite to that practised by the cormorants and some other species.

Although this is the first time that this bird has bred in these gardens, young have been reared in the Jardin d'Acclimatation, in Paris.

Peregrine Falcon Breeding in Yorkshire.

Mr. T. H. Nelson, in the *Field*, June 23, records the welcome news that a pair of peregrine falcons have succeeded in rearing a family of three during the present nesting season, thanks to the co-operation of the cliff-climbers of Bempton. It is just a quarter of a century since a pair of this species performed a similar feat. Mr. Nelson expresses a hope, in which all bird lovers will share, that the parent birds will not be molested during the coming shooting season; since, should they be spared, we may, as he remarks, see this ancient haunt re-tenanted, and thus an added interest will be secured to the magnificent cliff scenery of the Yorkshire coast.

Roller in Scotland.

The "Annals of Scottish Natural History" for July contains a record of the fact that a roller, *Coracias garrula*, was seen at Balnacoil, on the Brora, on May 28. The bird was watched for several days, its favourite perch being the end of the bare branch of a tree.

Iceland Falcon in Lewis.

Mr. J. A. Harvey Brown writes to the "Annals of Scottish Natural History" for July, to say that an Iceland falcon, which had been watched during several days on the Eye Peninsula, Lewis, was shot on February 28.

Honey Buzzard in Fife.

On May 21, according to the "Annals of Scottish Natural History" for July, a honey buzzard "was unfortunately shot" on the Largo Estate. It had apparently been seen hovering over a field in which young pheasants were being reared.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Radium and Electric Discharge in Tubes.

A few years ago, Wehnelt showed that the difference of potential required to produce a discharge through a vacuum tube is very much diminished if the cathode be coated with an oxide of one of the metals of the alkaline earths, such as barium oxide or calcium oxide, provided that the cathode is then raised to a red heat by means of an independent current. Mr. A. A. Campbell Swinton has quite recently tested whether radium coated on the cathode produces the same effect. Moreover, as radium gives off electrons when cold, it was anticipated that it might be unnecessary to heat the cathode. Using a cold cathode with a thin coating of the bromide of radium, and with a continuous current up to 400 volts pressure, this was found not to be the case. A very marked action in facilitating the production of a luminous discharge was, however, observed when the radium-coated cathode was heated; in fact, a pressure of 80 volts was then sufficient. Further experiments showed that it is not sufficient that the radium be in the tube; it must be on the cathode for the effect to occur. Whether the radium salt is more or less efficient than barium or calcium oxide is rendered doubtful owing to the very small amount of radium employed. With the quantity actually used the efficiency was less, but this might not be the case if more radium were available.

Decay of Radium A, B, and C.

Dr. H. L. Bronson is continuing his researches on the decomposition products of radium, and claims to have proved—

(1) That within the limits of experimental error the experimental decay curves agree with the theoretical decay curves, calculated on the assumptions that the three products, A, B, and C are successive, and that their periods are 3, 26, and 19 minutes.

(2) That radium B emits Beta-rays of less penetrating power than those from radium C; and that on this account the Beta-ray decay curves are unsatisfactory for the purposes of analysis.

(3) That these Beta-rays from radium B completely explain the divergence which Rutherford found between the experimental and theoretical Beta-ray curves.

Image in a Concave Mirror.

If a lighted candle be placed in front of a concave mirror between the focus and the centre of curvature, a real inverted image of it upon a screen can be obtained in a definite place beyond the centre of curvature. If the candle is placed so that this image is fairly distant, anyone looking into the mirror will see a second image of the candle apparently behind the mirror. Now since the rays from any point of the candle must be converging after reflection to a point on the real distant image, it follows that the image seen in the mirror must be seen by means of converging cones of rays. Any eye which sees this image with anything like perfect definition must be able to adjust itself to more than infinitely distant objects. Short-sighted people will not see the image except as a blurr of light. But it is astonishing how well-defined it can appear. And it is still more astonishing that, as far as I am aware, no text-book contains any account of this phenomenon. Instead of a candle, the observer may examine the image of his own face in this way, and it is interesting to observe the changes as the observer draws close to the mirror, when, of course, the usual, erect vertical image is obtained. Those interested in this question are recommended to draw the rays, in various cases, by which the images are seen.

The Magnetisation of a Magnet.

A curious misconception in very elementary text-books is as to the portion of an ordinary bar magnet which is the more highly magnetised. Examinees tell one *ad nauseam* that it is the ends which are so. Of course, it is near the ends that most external evidence is obtained of the bar being magnetised at all; that is, it is there that the so-called free magnetism is in evidence. But though it is perhaps not quite so obvious how to obtain proof of the statement, it is nevertheless true that it is the middle of the magnet that has the greater magnetisation. Those who are familiar with the molecular theory of magnetisation, which attributes magnetisation to the alignment of already existing molecular magnets, should have no difficulty in realising this fact, for it is clear that the reversing action of the free poles at the ends will tend to make the alignment less perfect near them. The fact that lines of force leave the magnet in the neighbourhood of the poles also points to the same conclusion; for it indicates that there must be more lines passing through the centre than near the poles, the rest having escaped. The simplest experimental proof is from the phenomena of induced currents. A coil of wire connected to a galvanometer is traversed by an induced current not only while the coil is being brought up to the pole, but while it is moved by stages over the magnet from pole to centre. The induced flow is due to the change in the number of magnetic lines threading the coil, and the direction of the flow is that corresponding to an increase in this number, as the centre is approached. The confusion, of course, is between magnetisation and free magnetism. Near the centre the magnetisation is great, but practically no free magnetism shows itself, because north and south kinds are present together in nearly equal quantity. Near the ends the magnetisation is less; but free magnetism, either north or else south, is conspicuous because there is very much more of one kind than of the other.

ZOOLOGICAL.

By R. LYDEKKER.

The Sea-Serpent.

INTEREST, for the moment, is concentrated on the account given at the meeting of the Zoological Society on the 19th of June by Messrs. Nicoll and Waldo, of their experiences of the sea-serpent, when cruising off Para on the morning of December 7 of last year. That these gentlemen, both experienced observers, saw some huge marine animal cannot be doubted; while their description of such portions of it as came under their notice does not enable us to refer it to any known group of living vertebrates. An especially noteworthy feature is that the description tallies remarkably well with that of the monster seen many years ago by the officers of *H.M.S. Dædalus*. Two great difficulties enter into the question of the existence of a sea-serpent, namely, the absence in Tertiary formations of the fossil remains of any such animal, and the infrequency of its appearances. Being presumably an air-breather (as otherwise there would be no occasion for its ever coming to the surface), it should make its appearance at comparatively frequent intervals and, therefore, ought to be seen not uncommonly.

The Indian Ocean.

At a recent meeting of the Royal Geographical Society, an important communication was made by Mr. J. S. Gardiner concerning the natural history and mode of formation of the Indian Ocean, based on an exploring expedition undertaken in *H.M.S. Sealark*. One of the problems specially considered was the manner in which the land-bridge formerly connecting Madagascar with Ceylon and India was removed. In the author's opinion, this was effected entirely by currents; but in the discussion it was pointed out that these could not have formed the basin of the Indian Ocean, which can scarcely be due to anything but subsidence, and consequently that the later changes were probably also due to the same agency.

The Fins of Fishes.

A controversy has been long in existence with regard to the origin of the paired fins of fishes, and thus the limbs of vertebrates generally. According to one theory, these fins are derived from gill-structures; the arches, or supports, of the gills having become modified into the shoulder-girdle (scapula and coracoid) and pelvis, while from the gill-flaps, with their supporting gill-rays, the fins themselves have been evolved. According to the alternative view, the fins are modified portions of a longitudinal fold of skin running along each side of the body. It is to be hoped that the controversy may be finally closed as the result of a paper communicated by Mr. Goodrich, of Oxford, to the June issue of the *Quarterly Journal of Microscopical Science*. Attention is there directed to the fact that the paired fins and the median fins are structurally similar; and that while this is in perfect accord with the lateral-fold theory, it cannot possibly be explained by the gill-theory.

South America and Africa.

In the course of a paper on the freshwater fishes of South and Central America, published in the June issue of the *Popular Science Monthly*, Professor Eigenmann expresses his opinion with regard to another much-debated question, namely, a former land-connection between South America and Africa.

"In the earliest Tertiary," he writes, "tropical America consisted of two land-areas, Archiguiana and Archamazonia, separated by the lower valley of the Amazon, which was still submerged. There was a land-mass, Hellenis, between Africa and South America, possibly in contact with Guiana and some point in tropical Africa. This land-mass, which was inhabited, among other things, by fishes belonging to the families *Lepidosirenidæ* (lung-fishes), *Pœciliidæ*, *Characinidæ*, *Cichlidæ*, and *Siluridæ* (cat-fishes), sank beneath the surface of the ocean, forcing the fauna in two directions, towards Africa and towards South America, and exterminating all types not moved to the east or to the west. From these two rudiments have developed the present diverse faunas of Africa and South America, each reinforced by intrusions from the ocean and neighbouring land-areas, and by autochthonous development within its own border. . . . The connection between Africa and South America existed before the origin of present genera, and even before the origin of some of the present families and sub-families, some time before the early Tertiary. There has never been any exchange between Africa and South America since that time."

Papers Read.

At the meeting of the Zoological Society, held on May 29, Messrs. Schwann and Thomas furnished a paper on Transvaal mammals; Mr. F. E. Beddard contributed notes on the vascular system of the Arizona poisonous lizard and certain other reptiles, and likewise described the external characters of a fœtal giraffe; while Dr. R. Broom gave a description of a South African fossil reptile. At the closing meeting of the session, held on June 19, Sir C. Elliot discussed the nudibranch molluscs of India and Ceylon; Mr. Rothschild described as new a zebra from Rhodesia; Drs. Brady and Chilton respectively contributed papers on the freshwater crustaceans of New Zealand, and Mr. Regan discussed the classification of sharks and rays.

CORRESPONDENCE.

"Eolithic Man."

To the Editors of "Knowledge & Scientific News."

Sirs,—I am inclined to ask if we are justified in endorsing M. Rutot's conclusion that Eoliths represent a period of stagnation in the practice of flint knapping? Hitherto the gradual improvement in Eolithic implements has been one of our mainstays in proving the authenticity of these forms, and the abandonment of this position will go some way towards the elimination of Eoliths as authentic records of pre-Palæolithic man. Neither can I follow M. Rutot's explanation of this supposed stagnation. The flints of Tertiary deposits are chiefly pebbles of small size, hard and irregular of fracture, and unsuited for the manufacture of implements; it was only during the post-Tertiary and more active denudation of the chalk that the more suitable flints were disinterred—hence in Eolithic implements of the earliest types we have small forms which might well have been manufactured from the small fragments lying ready to hand. Before that more active denudation the chalk was in a large measure covered by Tertiary, and therefore unsuitable, *débris*. If there was anything in the nature of a stagnation (a very unsatisfactory term in any evolutionary discussion—it was, I think, attributable to slow development of intelligence on the part of pre-Palæolithic man.

I would add that the photograph reproduced in your April number, although excellent as an illustration, cannot be taken as any argument against Eoliths. It is impossible to show by photography the differences between the Mantes pseudo-Eoliths and the genuine antiquities; the two forms must be closely studied side by side. At the same time, as I have before maintained in your pages, these pseudo-Eoliths must be eliminated from the argument, for they were produced by an essentially artificial arrangement.

It is only when an extensive series of implements is exhibited that the full evolutionary value of Eoliths can be properly estimated. If these forms are merely natural, then there should be an absolute identity of finish, but from the rudest Eolith to the finest Palæolith there is a connecting sequence, and there is no form at which it is possible to draw the line between Eolithic, or "natural" forms, and Palæolithic, or artificial forms, and this impossibility confronts our opponents for solution. There are forms which may be termed either late Eoliths or early Palæoliths; in which aspect the question at issue is reduced to one of mere terms and not facts.

J. Russell Larkby.

Buenos Aires, South America,
June, 1906.

Sand Mist in China.

To the Editors of "Knowledge & Scientific News."

Sirs,—I reside in Central China, on the river Yangtsi, 1,000 miles from the sea. The district is hilly. At certain times of the year, especially spring and summer, we are visited occasionally with sand storms. These are not blinding and thick like those met with in the North of China. They are sufficient to obscure the vision of the hills across the river, and to make everything like in a mist.

These storms generally come on with a strong wind from the north-east, but the cessation of the wind does not mean the settling of the sand. That continues to hang about for days, till a heavy shower of rain settles it.

That the sand or dust does not come from a local source can be proved from the fact:

That we have these storms when there are no sand-banks in the neighbourhood uncovered.

That the sand by the river is not fine enough to be suspended in the air after the wind has ceased to blow.

I write at this time to mention a peculiar phenomenon in connection with the last storm we had, on April 8.

On the Sunday morning, the air was most wonderfully clear, the hills, miles away, seemed near and distinct. By the afternoon a change came on, and a wind sprang up. That evening, and the next day, the air was quite obscure with sand or dust. On Monday night we had some rain and the sand was settled. As I was walking down the river-side on the next afternoon with a companion, we noted round the numerous rain pools which had partly evaporated, a ring of pure sulphur. This was not only in one small defined area, but as far as we walked and wherever there were these partly dried-up pools. As my companion was a doctor, his judgment could hardly be wrong that the substance was sulphur. Never before in my residence in this place have I noted such an occurrence.

Now, the question is, where did the sand or dust come from that had suspended with it so much sulphur? Could it have any connection with the recent eruption of Vesuvius?

It would be interesting to know if any of your readers noted anything of the same elsewhere, or can give any explanation of this in Central China.

I remain, yours truly,

Wm. Deans.

Church of England Mission,
Ichang, China.
April 23, 1906.

To Make Iron Grow.

To the Editors of "Knowledge & Scientific News."

Sirs,—In connection with Mr. Badgley's letter, it appears desirable to point out that a "globular molecular theory" (whatever that may mean, for this is not clear from the letter) involves a contradiction of terms. A "molecule" in physics has a certain definite meaning, and is characterised by certain definite properties, and the phenomenon in iron is easily accounted for consistently with these properties. There are plenty of treatises on physics from which your readers can obtain information as to theories of the constitution of matter, but any attempt to discuss even well-known theories in the limited space available in your columns is likely to be worse than useless. If Mr. Badgley believes he has discovered a new theory of matter, his best course would be to treat the subject closely on the lines of such standard treatises on the Kinetic Theory as those of Watson, Burbury, Jeans, or Osborne Reynolds. The method of exposition is all-important.

G. H. B.

The Eruption of Vesuvius.

By the courtesy of Dr. Tempest Anderson, of York, the well-known vulcanologist, we are enabled to reproduce a photograph of a stage of the recent eruption of Vesuvius, taken by himself, on April 26 last. The Observatory is to the left of the picture. In the centre is the cone of the eruption of 1898, now known as the Colle Umberto I°, while the cone of Vesuvius in the distance shows the tracks of ash-slides.

The top of the cone of Vesuvius before the recent outburst was situated at a height of 1330 metres, or 4,400 feet, and aneroid measurements, averaged with those taken by Mr. Perrett, of the Observatory, showed a loss of at least 350 feet.

Vesuvius—the Observatory from the Fossa Vetrana.

The recent eruption of Vesuvius (late stage).

The small figure is a photograph, taken during the eruption of 1898, showing Dr. Matteucci's Observatory, with lava in the foreground. The hill on which the Observatory is situated forms part of the great crater ring of Somma, but is separated from that part of the mountain by the valley, Fossa Vetrana. Vesuvius is to the left, out of the picture. The picture shows that the Observatory is secure from damage by any ordinary eruption.

It should be added that these photographs formed part of the lantern demonstration given by Dr. Anderson at the Royal Society's *soirée* on June 10.

Telephones and the American Accent.

It is said that the general use of the telephone in the United States of America is destroying the distinctive Southern intonation, and that the American accent is tending to become uniform all over the country. This is because the use of the telephone is bringing all normal voices to a sameness of pitch, and is engrafting a similarity of enunciation. That must especially be the case in long-distance conversations, because the talker has to exert a conscious effort in clearness and distinctness of enunciation. It is possible that from allied causes the character of spoken English might as a whole become changed. English is called by foreigners the hissing language, because of the predominance of the "s."

The Study of the Cell in the Higher Plants.

By H. A. Haig.

There are few things more interesting in the science of botany than an insight into the ultimate structure and vital processes presented by the cell; and in this article I shall endeavour to make clear some of the more important functions and structural details to be made out in those cells which are met with in the more highly differentiated members of the vegetable kingdom. It is, however, to be borne in mind that living cell-units may in all cases be reduced to one or more simple types, and that there is no essential difference in function between a cell from the assimilating tissue of the cortex in a higher plant, and that from a filament of an Alga, although there may be some difference in structure, in order to cope with surrounding conditions.

It will, perhaps, be well, first of all, to state concisely what we have to examine in any given cell, in order, and then to take each one of these and study it separately; and, finally, to sum up the attributes of the cell, and from this to try and gain some idea of the general value of the organism considered as a co-worker with others of the same kind.

In any given cell we shall have to study:—

1.—The general microscopical structure.

2.—The reaction of the cell to stimuli of various kinds.

3.—The reproduction of similar cells from pre-existing ones.

4.—The further modification of a cell as dependent upon its position and the functions it has ultimately to fulfil.

Further, I shall endeavour to compare the results of our observations with those arrived at by some of those biologists who have made the cell their special study. [Of the figures that illustrate the text, some are drawn from actual observation, and others are photo-micrographs. The methods of staining and preparation will not be gone into very fully, as space does not allow.]

1.—The general microscopical structure.

A cell from a growing-point, such as a stem apex or root-tip, serves very well for the study of structure in very young cells.

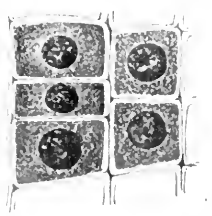


Fig. 1.

We have (see Fig. 1) an obvious cell-wall, and contained within this the protoplasm; about the centre of this latter is situated the nucleus, which is circular in outline and in general shape spheroidal. In these very young cells, the protoplasm appears to fill the whole cavity. It has a granular appearance, and these granules are possibly either protoplasmic in nature (microsomata) or food-particles, but the latter is doubtful, as most food-materials exist in the cell in a state of solution, except when they are in the form of reserve-materials.

These main features are seen if we make thin longitudinal sections of the given tissue, which must be stained (preferably with logwood), and properly mounted either in Canada balsam or glycerine.

There have been many assumptions made as to the ultimate structure and chemical composition of protoplasm, amongst these being Nägeli's micellar theory and the framework theory of Klein, Leydig, and others; but the one that appears to account best for the various physical properties of protoplasm is that due to Bütschli, the foam or honeycomb theory, although even to this there are objections.

There seems to have been a tendency recently to advocate this latter theory, on account of various sur-

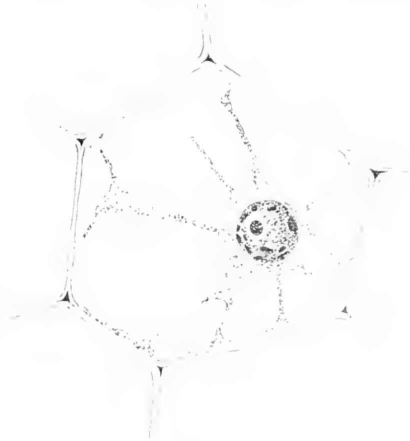


Fig. 2.

face-tension phenomena exhibited by emulsions, and certainly the appearances presented by protoplasm are in some cases very similar to these. But, whilst admitting the value of these observations, it is certain that they do not wholly unravel the physical structure of protoplasm.

If we examine somewhat older cells, that is, cells which have been carrying on their vital functions for some little time, it will be seen that the protoplasm no longer entirely fills the cell, but is thrown into "bridles" or strands passing from a larger central mass, which usually contains the nucleus, to the cell-wall on all sides (see Fig. 2). The spaces not occupied by protoplasm are usually filled with fluid, the cell-sap, and this contains some of the nutrient materials for the cell. The strands of protoplasm, as well as the central portion, are still granular, and in some cases it is possible to demonstrate fibrils passing between adjacent cells, the so-called "intercommunicating fibrils" (see Fig. 3). These are well seen in the cells of the young endosperm of Caltha palustris, and their importance we shall enlarge upon later. A well-known example of them exists in the communicating threads between adjacent sieve-tubes in the phloëm of the vascular system of higher plants.

The cell, as it gets still older, enlarges continually up to a certain point, but the protoplasm does not increase in volume proportionately, so that ultimately we have a central "vacuole" filled with cell-sap, and outside this, lining the inner surface of the cell-wall, is a

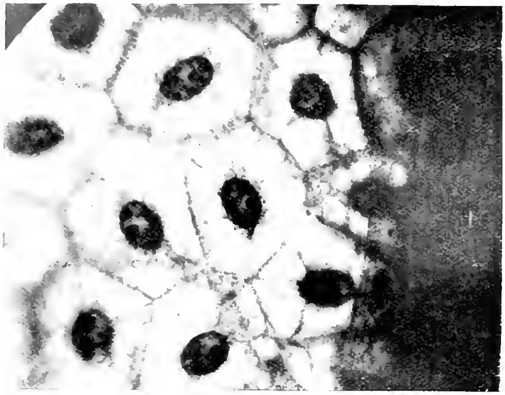


Fig. 3.

thin layer of protoplasm, in which is somewhere enclosed the nucleus.

This peripheral layer was first described by von Mohl as the "primordial utricle." It has a very important function, which we shall discuss further on.

The nucleus is a most important structure; as usually seen, it is a clear, rounded body, with a more or less

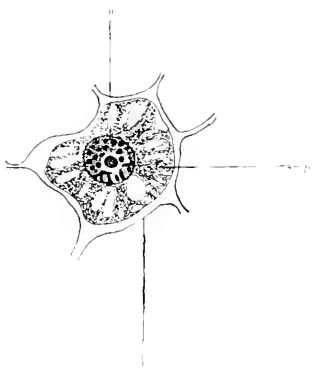


Fig. 4.—Young Cell from pith of stem of Lupulus. a. Cell-wall. p. Protoplasm (Endoplasm). n. Nucleus, showing nucleolus and chromosomes.

central dot, the nucleolus, in its interior. When carefully stained with logwood, it is seen to have a definite structure, the most frequent being a punctate or reticulate appearance, which about the time of nuclear division becomes very marked indeed (see Fig. 4).

Numerous observers have described a membrane, the "nuclear membrane," as the external contour of the nucleus, and the nucleolus, of which there may be more than one, also seems to have a vesicular structure. But more recently, it has been thought that the nucleus is a rounded space in the protoplasm, the margin of which is formed of firmer protoplasm (altered kinoplasm)* than the main mass.

With high powers of the microscope, and very careful preparation, it has been shown that two bodies, the "centrospheres" or "blepharoplasts" exist in the protoplasm very close to the nucleus. They are of importance in nuclear division (mitosis); but they probably do not exist as formed structures in the cells of plants higher than the Liverworts.

There are certain other structures present in the general protoplasm of a cell; these are the "plastids" or "chromoplasts," the former term being the best, as they do not always contain pigment. They are, like the nucleus, specialised portions of the protoplasm, and function as a rule in the manufacture of starch. Very often they may be seen grouped round the nucleus, but as yet the significance of this has not been explained. It is probable, however, that during active division, the nucleus requires a large supply of carbohydrate food, and in this case the nearer the plastids are the better. The chlorophyll granules so often seen in the cells of the green assimilating tissues are only plastids containing the pigment chlorophyll, and are here, of course, true chromoplasts.

A word or two requires to be said about the grouping of cells into tissues. A cell equally pressed upon all sides by other cells usually assumes the form of a regular dodecahedron, that is, on section, the figure is a hexagon. If the pressure is not even all round, then certain deviations from this natural rule exist, and we get on section four, five, seven, etc., sided figures. The rectangular prism is also a common form assumed by cells in cortical regions, where definite limited layers of cells exist, and the radial and vertical pressures are as a rule unequal. The natural form of the hexagon is seen well in the young pith of certain plants (Sambucus).

Although the shape of the cells in any tissue is thus to a large extent determined by external physical causes, the growth of the cell, as a whole, is brought about by the agency of the protoplasm, which takes in the various food-materials and transforms them into other substances, which form integral parts of the body of the cell.

We have now briefly examined the general features of the living cell microscopically, and have seen that it consists of several parts. Each of these parts has a definite function of its own, and the living portions of the cell, *i.e.*, protoplasm, nucleus, and plastids, are intimately related to one another in a way that we shall presently see. It is instructive to look upon the cell as a transformer of energy, and as a utiliser of the same, but it is only a limited view of the total function of the organism, for, as we shall see, there exists a mutual interdependence between the different living cells of any plant.†

2.—The reaction of the cell to stimuli of various kinds.

We have spoken of a cell as a living unit, and we have now to enquire into the manner in which the protoplasm responds to, in the first place, nutrition, and,

* The "kinoplasm" is that portion of the general protoplasm which lies just outside the nucleus; it is not so granular as the main mass.

† This view is well discussed in Kerner's Natural History of Plants, Vol. 1, Pt. 1.

in the second, to the various external forces that are brought to bear upon it. The fact that in some cells, notably those of hairs from the stamina of Tradescantia, the protoplasm has the power of movement, that is, is carried round the cell in varying directions, and that this movement depends upon a number of conditions, such as temperature, a requisite supply of oxygen, and some others, shows that this substance is "irritable," or, in other words, has the property of responding to stimuli.

An interesting fact is the observation that root-hairs, which are very elongated, delicate cells, can exert a certain power of selection when surrounded by a solution of various salts (a nutrient solution so-called) and this shows that the peripheral protoplasm of these cells is more irritable to certain forms of chemical stimuli than to others. Likewise the experiments upon masses of naked protoplasm, although here we are more rightly considering the cells of higher plants, show that it is directly irritable to other forms of energy, such as light and electricity. These experiments are to us useful, from the point of view of comparison, for, all things considered, the main difference is that in the case of cells of higher plants, which we are considering, a cell-wall exists, which in some way modifies the action of the stimuli.

We have called attention a little further back to certain intercellular communicating fibrils of protoplasm. These fibrils have been thought to be of use in the conduction of stimuli from any given cell to adjacent cells, and so on to those more remote. There is some evidence to show that this communication by fibrils is of value to a plant much in the way that so-called "trophic nerves" are to an animal with a well-marked nervous system, for cells that have been partially injured may revive if still in communication with other cells. But more proof is required before this can be definitely settled. One thing is, however, certain, namely, that nowadays one would no more think of calling a living cell an isolated unit than say that the cortical cells of the brain are functionally isolated portions of the central nervous system.

We must not, however, look upon the main mass of protoplasm in a cell as the only irritable part; the nucleus, the plastids, and, at certain times also, the centrospheres are influenced by stimuli reaching them either directly or from adjacent cells, for, as we have seen, these structures are one and all specialised portions of protoplasm. The plastids, however, are mainly irritable to certain chemical stimuli, produced chiefly by carbohydrates in solution, and, in the case of the chloroplasts, the pigment chlorophyll sifts out certain portions of the radiant energy reaching them from the outside and, co-operating with the chemical stimulus, so acts upon the protoplasm of the plastid that this latter is enabled to form starch. There is evidence for believing that the actual protoplasm of the chloroplast becomes transformed into starch, and, moreover, it has been shown that proteids can, as a rule, be split up into nitrogenous and carbohydrate portions, so that the transformation in the plastid is not so astonishing as at first sight appears. The same thing probably occurs during the formation of the cell-plate in indirect or mitotic cell-division.

The protoplasm responds to nutrition by (*a*) growth of its substance, and (*b*) growth of the whole cell. Assimilation is, however, the result of a number of stimuli, some chemical, produced by the various food-materials, others physical and depending upon light and temperature. It is the combination of these and a certain unexplainable (as yet) vital activity* which constitute metabolism, a term which includes both the building up and breaking down processes essential to the life of the protoplasm.

There are certain factors in the response of protoplasm to stimuli which must be present in order that such a response may be called out. These are, the presence of oxygen and a good supply of water, in which latter the oxygen is usually held in solution to a small extent. The existence of free oxygen in a cell enables the katabolic side of metabolism to be carried on, and the process is certainly as essential to the life of the cell in plants as it is to the animal cell. Water, on the other hand, is equally essential, for the protoplasm is largely composed of water, both chemically and physically speaking, and in the transport of materials from cell to cell it is of the highest importance.

These two substances, then, oxygen and water, being present, the protoplasm is in a condition to utilise and react to the various forms of energy which reach the cell from the outside, and the result is that the organism is enabled to carry on a number of processes, both physical and chemical, and in so doing, increase in volume, change in shape, and the production of other cells are brought about. That protoplasm has a directive action is evident from the fact that certain organs grow in different directions, but after all, this directive action is the result of the reaction of protoplasm to certain external stimuli, such as gravity (geotropism) of moisture (hydrotopism). The action of gravity in causing a root-tip to bend downwards is well established by experiment, and the discovery that a force in any direction (centripetal force) could replace gravity, has shown that it is really the given force which has influenced the directive action of the protoplasm of the individual cells. The true nature of this action is as yet obscure, but there are grounds for assuming that an attractive force, such as those we have taken as instances, in some way modifies the intensity of metabolism so as to cause greater rapidity of growth in those portions of a cell which are furthest from the attraction.

The fact that certain flowers will turn towards or away from light is another well-known instance of the reaction of protoplasm to external stimuli, and on the whole is due to the same cause, namely, increased growth on that side which is turned away from the stimulus. It is a well ascertained fact that more rapid growth takes place in darkness, when transpiration is at a minimum, than in the light, and the phenomenon of heliotropism is thus not astonishing, as those portions of a plant which are directed towards the most intense illumination should transpire most, and grow least rapidly, whereas in those parts turned away from the light the reverse should be the case. But although these observations serve as a gross explanation, they do not show us the true reason for the increased activity of the protoplasm. It is true that transpiring cells are in general less turgid than non-transpiring ones, and turgidity favours growth, so that here we may have a partial explanation.

Turning now to that point to which we directed attention some little way back, namely, that a living cell must not only be looked upon as an individual

* There appears to be some doubt as to the legitimacy of the use of the term "vital activity." See Huxley on "The Physical Basis of Life," in "Method and Results."

unit capable of working for itself, but also as being dependent upon others by reason of interprotoplasmic connections, we have several instances of the value of this conception, especially with regard to certain movements that are produced by tactile stimuli in plants such as the Sundew and Mimosa. In the former, contact of a small foreign body (preferably of an organic nature) with the glandular outgrowths on the upper surfaces of the leaves leads to a bending over of these outgrowths (hairs) so as finally to enclose the irritating substance. It has been shown that here the stimulus passes most probably by certain living elements of the central tissue of the excrescence, and that this stimulus finally influences cells at the base of the hair, which in turn alter their turgidity on one side of the hair more than on the other. It is, however, to the protoplasm that the effect is ultimately due, and it is upon this substance that the stimulus has effect. A similar result may be observed in the leaves of the Mimosa pudica, where a tactile stimulus, the rate of travel of which can be measured, produces a depression of, first, the leaflets and then the whole leaf, consequent on diminished turgidity in the cells of the pulvini situated at the base of the petioles.

In some of the lower plants, Spirogyra, for instance, it has been found possible, by suitably altering the surrounding conditions, to substitute amitotic for mitotic division; and it is to be assumed that in higher plants, mitosis has arisen in order to cope with altered conditions of existence, for we shall see that economy is of the highest importance to the cell-community, and mitosis affords an almost exactly equal distribution of nuclear substance in each of the two daughter nuclei. Moreover, in the higher plants, it is probably a very fixed and constant method of division, not readily changed to the amitotic form; and we shall here study mitosis as it occurs in the Gymosperms and Angiosperms. [In the following figures, the centrospheres have been omitted, as the methods of preparation of the sections were inadequate to show them, even assuming that they were present at all.]

In order to follow the karyokinetic changes properly, it is necessary to study, first of all, the minute structure of the resting nucleus. This body, as we have seen, is supposed by some to possess a definite nuclear membrane, which encloses at least three different portions, named respectively, nuclear plasm, nuclear network, and nucleoli. The network is composed of a

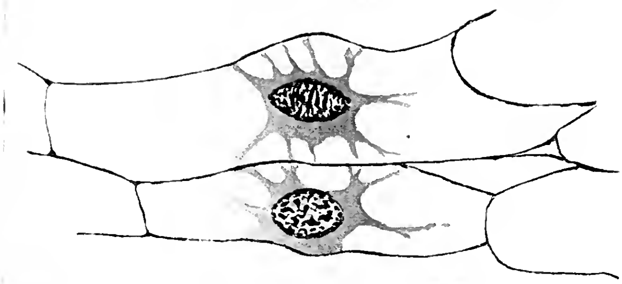


Fig. 5a.

We have now briefly considered the effect of some of the commoner stimuli upon the protoplasm. The manner in which the latter responds is not the same in all cases, and in some parts of a plant a given stimulus might produce an effect which it would not call forth in a more remote part, and *vice versâ*. There is, however, a certain "specific irritability" inherent in the protoplasm of various parts of a plant which enables it to make use of one or perhaps several stimuli in excess of all others, but what this is due to is not known. Perhaps heredity has some value in the explanation of this curious, yet undeniable fact; and we shall see later the effect of "position" upon the cells of any part of a plant.

3.—The reproduction of similar cells from pre-existing ones.

In the higher plants, cell-division is always preceded by nuclear-division, or karyokinesis; in some instances, however, the formation of definite cell-walls does not immediately follow division of the nucleus, notably in the process known as free cell-formation, where a large number of nuclei are first formed, lying free in a shell of peripheral protoplasm in the embryo-sac.

In a few cases, the nucleus is capable of "amitotic" division, that is, simple fission into two more or less equal portions, but in this case, no fresh cells are formed, and the nuclei simply increase in number.

substance known as linin, which is, according to various observers, unstainable by logwood, and on the meshes of this network are situated at certain points, small masses of a substance known chemically as nuclein, or chromatin, which stains deeply with logwood, and the more so the nearer the time for division approaches. The nucleoli (one or more, as the case may be) form well-marked masses at certain points of the network, but are usually quite distinct from this latter; they stain with logwood, but show some differences when the nuclei are treated with a compound stain, so that nucleoli are stained differently to the other nuclear structures.

If centrospheres are present, they will be seen close to the nucleus, in the surrounding protoplasm (kinoplasm); but it is not at all certain whether these bodies are present near the resting nucleus or whether they are rather to be looked upon as originating from a nuclear structure about the time that karyokinesis is about to start. If we examine a longitudinal section of a rapidly growing root-tip, in which the nuclei are of a good size (hyacinth roots serve excellently), and in which the various staining processes and subsequent preparation have been carefully carried out, we shall find instances in different cells of all stages in mitosis. The earlier stages are easily made out from the very different staining reaction shown by the masses of chromatin, which appear of various shapes, and more or less separated from each other, as in a resting nucleus. This is the stage of preparation, and in very careful preparations it is possible to make out the existence near the nucleus of a peculiar body, the "nuclear spindle," as yet quite small, but subsequently attaining a much larger size. The spindle is said to be formed from the kinoplasm, but all observers do not agree on this point. The first stage (without the spindle) is shown in Fig. 5a, which shows two nuclei, one of which is in the first or preparatory stage, the other (more spindle-shaped) one being in the second or spirem stage. The other part of the figure shows an early spirem.

Fig. 5b.

In the following stage, the masses of chromatin seem to join up into one long thread, which has the appearance of a skein, and hence known as the "spirem" phase (see Fig. 5a). The poles of the nuclear spindle have travelled further apart, and if centrospheres are present, they are seen one at each pole. Since the separate threads of which the spindle is composed do not stain with chromatin staining dyes, it is further known as the "achromatic spindle."

Fig. 5b shows a nucleus in a preparatory stage.

(To be continued.)

REVIEWS OF BOOKS.

ASTRONOMY.

Astronomy in the Old Testament, by G. Schiaparelli. Authorised English translation. (Clarendon Press, Oxford; 3s. 6d. net.)—This is a disappointing book, disappointing not so much for the manner in which it is written, but in that the investigation gone into is so barren of results. It might be expected that there would be numerous allusions in the Old Testament to astronomical phenomena, which might bear explanation, and be of the highest interest. But very few are here described. Again and again we are told that such and such a statement *apparently* refers to such and such an astronomical event. But there is no certainty all through; all is conjecture, and most of the quotations are practically unexplainable. And the book even tends to some confusion; in one part it is stated: "We are led to the important conclusion that . . . the Hebrews had some knowledge of the seven planets," and yet in another part, "Of the planets considered singly, two only can be traced in the Old Testament." Though of but negative interest, the book should prove of great use to those who wish to investigate this subject. It would have been the better for an index.

Giant Sun and His Family, by Mary Proctor (Silver, Burdett and Co., New York, Boston, and Chicago, 1906; pp. viii. + 197, with frontispiece and illustrations). Without displaying the facility and erudition of her celebrated father, the authoress of the present work has succeeded in producing a volume of great interest to young readers. It is professedly an epitome of a series of lectures, and as such is not free from some of the drawbacks associated with a work of that kind, especially in regard to the balance of the different parts of the subject, the three eclipses actually witnessed by the writer being allotted needlessly large space, with repeated detail from nearly parallel accounts, considering that space had also to be found for much other solar work, besides the chapters on the many members of the "Giant's" family. As a book for children, its primary object, the volume should find a ready welcome; but as a text-book, it is not beyond reproach. Apparently the writer's desire to avoid even such a harmless technical term as "section" may be held responsible for the ambiguous statement that the moon's shadow is "of the same general shape as itself, that of a *long, narrow cone.*" We might also allege looseness of expression, if not inaccuracy, against the remark that Halley and Encke discovered the comets that bear their respective names. The illustrations are nearly all good, though the lunar landscape which forms the frontispiece may not be convincing.

Modern Cosmogonies, by Agnes M. Clerke (London: A. and C. Black, 1905; pp. vii. + 287; 3s. 6d. net).—Most of this work should be familiar to the readers of "KNOWLEDGE," thirteen of the sixteen chapters having already appeared in its pages some before and some after the change in the title of the magazine. Miss Clerke's well-known literary style, with its fertile command of language and facility of luminous expression, is beyond criticism. Any reader of her other works will be prepared by the very title of the one before us to find her revelling in word-pictures of the sublime speculations of philosophers and scientists as to the origin, progress, and destiny of the universe, a subject of sufficient scope for the most ardent inquirer. From Thales to the new Satellites of 1905, though naturally in a work on Modern Cosmogonies only one chapter can be spared for the predecessors of Kant, hardly a single worker who has really added anything, however small, to the subject, goes without recognition by Miss Clerke, whose instinct may perhaps at times see more in such contributions than their originator probably contemplated, and accordingly do him more than justice. A great subject treated in a masterly manner, and, withal, a very readable book. But the last word on Cosmogony is not yet written, and we imagine it will not be long before new quantitative investigations of tidal friction, new refinements of spectroscopy, or new speculations as to ether, protyle, or the genesis of organisms may be demanding new editions, revised and enlarged, which we hope the gifted authoress may long be spared to provide.

BOTANY.

A Revised Key of the Hepatics of the British Islands, by Symers M. Macvicar (Eastbourne: V. T. Sumfield; 9d. post free.)—This appears to be mainly written for the use of beginners, to whom it will be of service in ascertaining the name of a plant, which can afterwards be verified, and fuller details obtained from a more advanced text-book. Some useful information is given in the preface, as to the points to be noted in the examination of a specimen.

CHEMISTRY.

Joseph Priestley, by T. E. Thorpe, F.R.S.; pp. ix and 228. English Men of Science Series (Dent and Co.)—The work of the chemist does not "touch life," to use an Americanism, at many points, and so the world has not had its interest awakened in the lives of many of those who helped to build up chemistry into a science. Thus, if you ask an average Englishman what he knows about Priestley, he will probably tell you that he had something to do with the discovery of gases, and that his house was burned in the riot at Birmingham; but of the man himself, or of his surroundings, he will know nothing. We, therefore, owe a debt to Dr. Thorpe for giving us in an accessible and very readable form a life of Priestley which, though of necessity too brief, yet brings the man and his time vividly before us. The account, which is to a large extent based on autobiographical notes, gives us incidentally a succession of pictures of middle-class life in the latter half of the 18th century. We follow Priestley through his boyhood among the handloom weavers in Yorkshire, his training for the dissenting ministry, his struggles as a minister, "passing rich on forty pounds a year" (a large amount of which he did not get), his more successful venture as a private schoolmaster, and his appointment in the Warrington Academy, where his scientific career may be said to have begun. Then come his marriage, his association with Lord Shelburne, his life in Birmingham, where he became a prominent member of the Lunar Society, the violent attacks made upon him from all sides at the height of his scientific career, on account of his supposed sympathy with the French revolutionists, his virtual banishment from England, and his settling and death in America. Dr. Thorpe has dealt with all these chapters of Priestley's life concisely, but yet sympathetically, and with sufficient detail to give a clear idea of the man, strong, and ever struggling against circumstances to express what he believed to be the truth, both in religion and in science. The last chapter, dealing with the chemical work of Priestley, is, perhaps, somewhat too abstruse for the general reader, but it will be read with the greatest interest by the chemist, for Dr. Thorpe brings out clearly how often Priestley was on the very verge of great discoveries, which he missed solely through his reluctance to part with the old doctrine of *phlogiston*. As Dr. Thorpe remarks: "Priestley was in fact a pioneer; he showed the existence of a new world for science, and he himself roamed over a portion of it, like a second Joshua; but he had not the experience or the aptitude to map out accurately even that fraction."

Chemistry Lecture Notes, by G. E. Welch, B.Sc. (London: Blackie and Son; pp. 63, 1s. 6d.)—The notes given in this little book are such as should be taken by students working at stage II. of Inorganic Chemistry. They are clear and concise, and should be of use in going over the ground before an examination. Yet, in spite of the author's remark in the preface, that "Much valuable time is wasted in note-taking," we cannot help thinking that the stained notes of the student, written down in his own words at the time of the experiment, are of infinitely more value as a training in chemistry than mastering these model notes, which he can assimilate for examination purposes and then forget.

GEOMETRY.

Geometry, Theoretical and Practical, by W. P. Workman, M.A., B.Sc., and A. G. Cracknell, M.A., B.Sc., F.C.P., price 3s. 6d. If the University Tutorial Press is guilty of producing a further addition to the already overflowing list of "Geometries" recently brought out "to meet modern requirements," it cannot be said that the addition is in any way unjustifiable. Since the bygone days, when a small circle of authors commenced to write books for the then new and practically unknown series, a noticeable feature of these books has been the absence of mere repetition of methods, good, bad and indifferent, contained in previous text-books, and those who are behind the scenes know that in many instances, the improvements which have seen the light in these books have only been effected by considerable expenditure of time and money. The new Geometry contains abundant evidence that the authors have succeeded in impressing their own individuality on even this well-worn subject by the introduction of many desirable and novel features; indeed, under the circumstances, the book strikes us as one of noticeable originality. It commences with an introductory course in constructive Geometry not only of plane figures, but of the simple solids, and throughout the remainder of the book a careful balance has been maintained between theoretical deductions, constructive exercises, exercises solved by calculation, and riders. We do not altogether agree with the arguments for abolishing Euclid contained in the preface, and we believe that the real facts of the case are but little understood. So far as order of treatment, and so forth, is concerned, the Geometry of the present day is not new; the "Text Book of Science," by Watson, published considerably over a quarter of a century ago, being identical with it even in many such points of detail as the admission of "hypothetical constructions." But if Watson had lived in the time of Euclid and Euclid had lived in the time of Watson, a change from "Watsonian" to "Euclidian" methods might equally well have been heralded as a reform. Where the real improvement comes in is in furnishing Geometry with "examples," similar in point of relative difficulty to the examples by which beginners learn arithmetic and algebra. It is remarkable that while, as the authors say, "the Euclidian methods of the year 1900 represented the accumulated experience of many generations of competent teachers," these teachers had never devised any plan of teaching otherwise than by making their pupils either learn up the propositions or putting them on to solve hard riders which many of them never could solve, and which the teacher himself had in most cases to solve for them. The introduction of the ruler, compasses, and protractor has now supplied beginners with plenty of examples which they can work out for themselves, and learn something in working them. We are glad to see that the chapter on loci contains an exercise on plotting an ellipse, and that in connection with "hypothetical constructions" the reader is warned against the mistake, of which "join O to P bisecting the angle A O B" is a common instance.

NATURAL HISTORY.

Recreations of a Naturalist. By J. E. Harting. (London: T. Fisher Unwin, 1906, pp. xvi. + 233, illustrated; price 15s. net.)—Mr. Harting is such an old favourite with the nature-loving public that any work from his pen is almost sure of a favourable reception. He has, moreover, the advantage of being not only a first-rate field naturalist, but likewise an ardent sportsman, and also, to some extent, an antiquarian, having a very large acquaintance with early English and foreign literature. He, therefore, appeals to a much wider field than that with which the majority of writers on popular natural history are obliged to be content. The articles in the volume before us have already appeared in the *Field* (without, in most instances, the illustrations, which add to their attractiveness), and the author has accordingly had the opportunity of revising his views when necessary. They cover such a wide range of subjects as hawking, grouse and black-cock shooting, distribution of partridges, origin of the cat, sheep-dog trials, bird life on the Norfolk Broads, swan-upping on the Thames, and the oldest work on angling. To be an expert on such a diversity of subjects alone proclaims great capacity and industry, and if the author is a little less up-to-date in some of the articles, such as the one on the ancestry of the cat, he may well be excused. We have read the book with pleasure, and can heartily commend it to our subscribers.

PHOTOGRAPHY.

Successful Negative Making, by T. Thorne Baker, F.C.S., F.R.P.S. (London: Marshall, Brookes and Chalkley, Ltd.; price 6d.)—This, the first of the "Focus Photographic Manuals," is a small volume of forty-one pages divided into five chapters, dealing with the plate, exposure, development, fixing, washing, intensification, and reduction. Some of the statements in the book are not orthodox, as, for example, that a colour screen is less needed when the colours are brilliant and "rich" than where there is a great deal of reflected white light, and that, in general, the colour screen or filter must be suited to the view; that "for lantern slide making one wants really harsh negatives to get the best results;" that in intensification, "during re-blackening the silver mercurous compound formed in the bleaching is reduced to metal," while the very first blackening formula given has not this effect; that "the smaller the stop, the finer will be the detail, the more vigorous the negative, and the greater the latitude in exposure;" and so on. Notwithstanding such statements, the manual will be found useful by beginners, and the three illustrations showing the same subject as taken on a slow, a medium, and a rapid plate will be a welcome guide to many in their choice of plates.

Photographic Enamels. From the French of René D'Héliécourt (London: Iliffe and Sons, Limited, 1905; price 2s. 6d. net).—The production of enamels is a branch, or rather perhaps an application, of photography that is hardly referred to in general text-books, for the sufficient reason that it is only an exceedingly small proportion of those who are interested in photography that care to trouble themselves about it. But the making of photo-enamels has had a measure of commercial importance for a generation or more, and is an art that deserves more patronage than it receives. It is, moreover, a very interesting subject for an amateur to work at, especially if he has had any experience in chemical operations, and the manipulation of furnaces. We therefore welcome this translation of that part of M. René D'Héliécourt's "La Photographie Vitrifiée" that refers definitely to this subject. The instructions given are clear and concise, and are not confined to one method, but satisfactorily cover the subject. It is essentially a practical guide, and will be much appreciated by those who wish to experiment in this direction.

PHYSICS.

Physical Optics, by R. W. Wood (Macmillan and Co.; 15s. net). This is in many respects a notable book, in so much as it may be considered supplementary to previously existing text-books. In Preston's "Theory of Light" the most modern developments are practically ignored, and although the gap is in part filled by more recent text-books, there was great need of one which should deal adequately with the experimental as well as the theoretic side of the subject. Special stress has been laid on this in the present volume, and all who have followed the numerous publications of Professor Wood during the last ten years will cordially recognise that no one could have been found with a better equipment for the work. Some may regret that the theoretic side is sometimes rather cramped; we advisedly used the word "supplementary" above. The reader may often require to turn to other sources for further information. The aim of the author has been chiefly to supply what cannot be found elsewhere in collected form. The treatment of the subject is eminently original. For a book of its standard, it is unusually full of numerical illustrations of theory. This will be found of great help to a private student. The experiments, specially devised by Professor Wood, are often of a very simple character, which an amateur may carry out. Special stress is laid on dispersion, absorption, the optical properties of metals, fluorescence and phosphorescence, the nature of white light, the relative motion of the ether and matter. The explanations are based mainly upon the electromagnetic theory. There are a large number of figures in the text; and very many of these have a very fresh appearance. We notice a few mistakes; the author repeats a common error in asserting that all the secondary maxima of a diffraction grating are given by the equation, $n \tan z = \tan nz$; it has fairly recently been pointed out that when n is odd, one such maximum fails to be included in this set. The proper expression, which includes all, is $n \cot nz = \cot z$. The figure (Fig. 144) which shows the graphical solution of the insufficient equation is wrong in showing a solution at π/n; such a solution does not exist. There are other misleading statements in the same section. The book, however, is wonderfully free from errors of all kinds, and it will doubtless at once take a leading place as a text-book for senior students.

MISCELLANEOUS.

"Science Progress." Science Progress in the Twentieth Century. A quarterly journal of scientific thought. No. 1, July, 1906. (John Murray, 5s. net). After some years of discontinuance the courageous attempt to present periodically a competent review of current scientific work for scientific readers has been revived under its old title of *Science Progress*. The attempt was courageous formerly, and it failed from a want of support among scientific people who are, perhaps, too prone to become immersed in their own special subjects and to neglect and lose touch with progress in other branches of science. But the attempt is no less courageous now, because while science tends more and more to specialisation, the public or popular interest in science—perhaps owing to the fact of specialisation in science—grows less and less. In the so-called dead sciences specialisation and mathematics are lifting their details far above the heads of the public, and in the "natural" sciences cycling and the camera have diverted popular attention from more sedate pursuits and from the quiet observation of Nature. None the less, we hope and believe that *Science Progress* in its new garb and condition will find a public of its own, as it well deserves to do. Great Britain, despite the scientific ignorance of the great mass of its people, and despite the natural unwillingness to spend money on scientific literature, is very well served by its scientific periodicals, two of which will compare with the publications of any other country. But it needed a more solid review, a kind of *Nineteenth Century and After* of science; and we sincerely hope that *Science Progress* will prove the real scientific quarterly. It makes an excellent start in its first number with articles, among others, by Dr. B. J. Collingwood on "Chloroform a Poison"; by Mr. A. D. Hall on "The Solvent Action of Roots on the Soil Particles"; by Mr. F. V. Theobald on "Injurious Insects"; and articles on "Chemical and Structural Crystallography," by Mr. A. E. H. Tutton; on "The Geological Plans of Some Australian Mining-Fields," by Mr. J. W. Gregory, F.R.S.; on "The Corn Smuts and Their Propagation," by Dr. T. Johnson; and on "Nehemiah Grew and the Study of Plant Anatomy," by Dr. Agnes Robertson.

Vivisection; Doubtfully Useful and Certainly Wrong, by J. P. Hopps. (London: Henderson, 1906, 42 pp.; price 6s. 6d.).—The author of this pamphlet may be congratulated on the thoroughly temperate and fair manner in which he has argued the case against vivisection. In many respects, especially as regards prohibition of vivisection without anaesthetics, we are disposed to agree with his views; although we may be permitted to doubt whether he has demonstrated that vivisection is useless. One point he seems to have missed, namely, that vivisection might perfectly well be prohibited altogether for a period, till some special new subject requires investigation. That the practice ought to be abolished when employed merely for purposes of demonstration we are convinced.

Ethics, by C. W. Saleeby, M.D. (Jack's Scientific Series; price 1s.) This forms an excellent little treatise on that abstruse subject, Ethics, and the connections between morality and religion. Some of the most interesting chapters are those on "The Object of Life," "Egoism and Altruism," and the "Worship of Truth." There is much to ponder over on reading this book, and as it only fills 115 small pages, it is not too tediously long, as is the case with many other works of the kind.

"Spiritualism," by Edward T. Bennett, is one of Jack's Scientific Series (1s. net). Both believers and non-believers cannot fail to be highly impressed with the many uncanny stories here told. Mr. Bennett was assistant secretary to the Society for Psychical Research, and, therefore, is in a good position to obtain all the best and most reliable accounts of the strange things that have happened in investigating this subject. And he, very rightly, takes care to repeat only statements of facts which are thoroughly well authenticated. Accounts of movements of objects, production of sounds, and appearance of light without any apparent physical cause, form the chief part of the contents of the book, while chapters are also included on The Divining Rod, Thought-Transference Drawings, Materialisations, and other matters.

The Engineer's Pocket Dictionary, French-English, by M. Lyoff (Percival Marshall, 1s. 6d. net), is a most handy and neatly got-up list of technical words in French, with the English equivalent.

MICROSCOPY

Conducted by F. Shillington Scales, B.A., F.R.M.S.

Royal Microscopical Society.

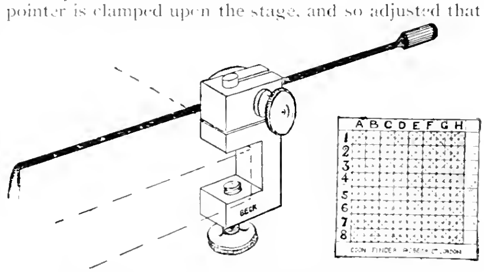
June 20, Dr. Dukinfield H. Scott, F.R.S., President, in the chair. Mr. J. T. Holder exhibited and described an old microscope made by Andrew Pritchard in 1846, which had been lent for exhibition by Mr. W. R. Reeves, of Liverpool. Dr. Hebb exhibited some high-power stereo-photo-micrographs of diatoms at magnifications of 500 to 2,000 diameters, received from Mr. Dollman, of Adelaide, South Australia. The President read a paper on "The Structure of some Carboniferous Ferns." He pointed out the change which had taken place in the last three years in our conception of the carboniferous ferns, so many examples of fern-like plants being now known to have borne seeds or being suspected of having been seed-bearers, that comparatively few undoubted ferns were left, and it was questioned whether, at least, in the Lower Carboniferous true ferns existed. One family, the Botryopterideæ, was admitted to be well represented in Lower as well as Upper Carboniferous times, and Mr. Newell Arbor has proposed to establish a group of Primofilices to include this and other primitive ferns of the Palæozoic age. The object of the communication was to give a few illustrations of the ancient race of ferns. The Botryopterideæ were first described, beginning with the type genus *Botryopteris.* The genus *Zygopteris* was next considered, and a new genus from the Lower Coal Measures of Lancashire, for which the name of *Botrychioxyton* was proposed. Two or three other examples of the family having been noticed, Dr. Scott described certain annulate fern sporangia. The germination of spores within a sporangium was demonstrated, and this sporangium had quite recently been identified as belonging to *Stauropteris oldhamia.* The paper was illustrated by fossil and recent sections thrown on the screen, and by lantern slides.

Quekett Microscopical Club.

June 15. Mr. A. E. Hilton read a paper "On the Study of the *Mycetozoa.*" Having referred to the still existing uncertainty as to the correct classification, the lecturer dealt with the distribution and general habitats of the group. The life-cycle in brief is: The spores, usually about 10 μ in diameter, rupture when immersed in water, and jelly-specks, each with a nucleus and two or three vacuoles, are liberated. These are the swarm-cells. They assume first an amœboid form, and subsequently resemble flagellate infusoria. After multiplication by encystment and division, they coalesce into a larger mass, the plasmodium; this, after slowly creeping about after food on decaying vegetable substances, ultimately comes to rest and throws up sporangia, which vary from $\frac{1}{50}$ to $\frac{1}{5}$ of an inch in height. The sporangia scatter spores and a new life-cycle begins. These various stages were described at length with reference to a series of coloured drawings of *Comatricha obtusata,* one of the commoner forms. Members yet undicided as to what line of research to follow were strongly urged to take up the study of this group. Its simplicity, especially when compared with botany or entomology, was pointed out, and books were named, dealing with the subject, and hints on the collection and cultivation of specimens were given at length. Mr. Hilton exhibited a large number of specimens of *Mycetozoa,* under microscopes, and Mr. J. Burton showed some active swarm-cells of *Brefeldia maxima.*

New Object Finder.

Messrs. R. and J. Beck, Ltd., have sent me for inspection a new finder, by Mr. J. M. Coon, which was recently exhibited at a meeting of the Royal Microscopical Society, and which is designed for use on the ordinary plain stage of any microscope. There is a special label for attachment to the microscope slip, and a pointer with universal movements and clamps for attachment to the microscope stage. This pointer has two points, as illustrated herewith. The label will be seen to be ruled in squares, numbered horizontally and lettered vertically for convenience of reference, and sub-divided into sixteen equal triangles for further refinement if necessary. In addition, two "focussing marks," or adjustment marks, are provided. The label being affixed to the right of a slide in the usual way, the objective is focussed on the left-hand mark. The pointer is clamped upon the stage, and so adjusted that



the main point lies upon the right-hand mark, and the other point is on the straight line upon the end of which this setting mark is situated. It is obvious that when the slide is now moved bodily to the right so as to bring the object itself into the field of view of the microscope, the pointer (which has not been moved) will, if an ordinary 3 by 1 inch slide is used, come to point over some of the intersecting lines of the label. These are noted, and either the letters and numbers are taken, or two ink-spots are made as a register. To find an object, it is therefore only necessary to repeat the process and to again move the slide until the pointer stands over the register marks. A microscopist can thus not only register a slide for use even with high powers, but can send it to another observer with instructions that will enable him to examine any portions so registered. The price of the finder, with labels, is half-a-guinea.

Stain for Photo-Micrography.

A note in the current issue of the Journal of the Royal Microscopical Society, gives the following stain as being recommended by Mr. E. Moffatt, for photo-micrography:—Fuchsin, .06 grm.; methylen-blue, .04 grm.; alcohol (90 per cent.), 5 c.cm. Add aqueous solution of carbolic acid, 5 per cent. to make up to 25 c.cm. Make films from cultures, in the usual way, and flood with the filtered stain; warm gently, wash well, dry in air, and mount in balsam. This solution is a very powerful stain, and used as above, gives excellent results with diphtheria, anthrax, cocci, and other bacteria, rendering these organisms very easy to photograph when the film is prepared from a pure culture. The solution, when diluted, is serviceable for section staining.

Acetone-celloidin Method of Rapid Embedding.

F. Scholz places pieces of material not thicker than 3 mm. in pure acetone for half an hour. They may then be transferred to celloidin, though it may be necessary to pass certain material through alcohol-ether for 15 minutes. The pieces remain in a thin celloidin solution for 4 to 5 hours, at 37° to 40°. They are then transferred to a thicker solution for 2 to 3 hours, after which they are placed in thick celloidin. In the last condition they are submitted to the action of chloroform vapour, in a closed vessel. In about 14 hours they will be of the consistence of cartilage. The blocks are next further hardened in alcohol for some hours.

Origin of Parasitism in Fungi.

Mr. George Massee, in a paper read before the Royal Society, concludes with three interesting statements as to the origin of parasitism in fungi: (1) The entrance of the germ tubes of a parasitic fungus into the tissues of a living healthy plant depends on the pressure of some substance, in the cells of the host, attractive to the fungus. In other words, infection is due to positive chemotaxis. (2) A saprophytic fungus can be gradually educated to become an active parasite on a given host-plant, by means of introducing a substance positively chemotactic to the fungus, into the tissues of the host. By similar means a parasitic fungus can be induced to become parasitic on a new host. (3) An immune plant signifies an individual of the same species as the one on which a given species of fungus is parasitic, but which, owing to the absence of the chemotactic substance in its tissues necessary to enable the germ-tubes of the fungus to penetrate, remains unattacked. The author made a series of experiments to verify these statements, using the expressed juice of leaves as culture solutions, and testing the presence of the chemotactic substance by sowing fungus spores on a mica film, in which a hole had been bored, and placing it in contact with the juice. If the chemotactic substance were there, the germinating tube of the spore grew towards the hole. He also found that the chemotactic property could be destroyed by the addition of certain reagents, such as a trace of acetic acid, etc. In order to educate a plant to become host to any parasite, he injected into the tissues some substance chemotactic to the fungus. Thus he induced *Penicillium* to invade the leaves of *Tradescantia discolor*, by injecting into it a solution of cane-sugar. Other saprophytic species were induced to become parasites on *Begonia* leaves by the same method, and after fifteen generations they grew as parasites without any addition of a sugar solution.

Cheap Glass Lenses.

A German publication mentions a cheap and simple way of obtaining large lenses for photographic and similar work, by forming a combination of ordinary watch or clock glasses with water or other suitable liquid. Two glasses, whose edges must be well ground so as to fit closely when in contact, are dipped into the liquid, and removed bodily filled with it. The edges are then wiped dry, and moistened with water-glass, which, helped with a little hydrochloric acid, sets quite hard, so that the "lens" can be freely handled. This process is assisted by the use of a peculiar brush, having two pencils on one shaft. As this brush is passed round the periphery, the front pencil wipes off the superfluous fluid, and the following pencil applies the water-glass. By means of a glass disc and a watch glass, a plano-convex lens can be made, and several other forms are possible.

New Triple Stain for Cytology.

Dr. Victor Bonney has devised a modification of Flemming's "Triple Stain," for cytological and histological purposes, which gives a sharp differentiation between the various constituents of the nucleus, cytoplasm, and inter-cellular tissues, and is at the same time simple, rapid, and reliable. The object of Flemming's original method was to combine in the tissues the stains saffranin, gentian-violet, and orange G, so that the chromatin substance of the nucleus should be stained by the gentian-violet, the cytoplasm by saffranin, and the inter-cellular substances by the orange. The method has, however, fallen into some disrepute on account of its uncertainty. Dr. Bonney's modification is as follows: (1) Fix small pieces of the tissue in acetic alcohol for five to fifteen minutes, according to size (*pure* glacial acetic acid one part, and *absolute* alcohol two parts). Dehydrate rapidly in several changes of absolute alcohol. (2) Embed, cut, and mount in the usual manner. (3) Stain for one hour in a saturated watery solution of saffranin. (4) Wash in water. (5) Stain for a quarter of an hour in a saturated solution of methyl-violet. (6) Wash in water, *and wipe the slide dry, except that part occupied by the section.* (7) Have ready in a drop-bottle the following solution: To 20 c.c. of acetone add, *drop by drop*, a saturated watery solution of orange G, until the flocculent precipitate, which slowly appears on shaking, is just dissolved in excess of the watery solution; then filter. (8) Flood the slide with this solution. A cloud of colour immediately comes out, which obscures the view of the section. (9) Pour this off on to blotting-paper and flood again with the same solution. The colour cloud being much fainter, the section can be watched. (10) When the section has attained a *rather faint* brownish-pink colour, pour off the orange-acetone solution. (11) Wash in acetone for a few seconds. (This should be contained in a small glass jar, acetone being very volatile; care should be taken that the section does not dry.) (12) Wash in xylol. (13) Transfer to low-power microscope and see if the proper result has been attained. (14) Wash in two fresh changes of xylol. (15) Mount in xylol-balsam.

All chromatic elements, nucleoli, and certain nuclei, such as those of polymorphonuclear leucocytes, stain a rich violet, chromosomes standing out with peculiar distinctness. The spindle fibres of nuclear mitosis stain a faint pink. The cytoplasm stains a rose pink. The inter-cellular tissue stains a pale yellow. These effects are best seen if the slide be examined through a deep blue screen. The most important factor in the process is the orange-acetone solution. If this is allowed to act too long, the whole section is stained a deep yellow, while if it has not acted long enough the section is blotchy and has a distinct violet tint. If the colours are discharged too rapidly, the orange-acetone must be diluted with acetone. The reagent deteriorates after a time.

Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.

The Face of the Sky for August.

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

The Sun.—On the 1st the Sun rises at 4.23 and sets at 7.48; on the 31st he rises at 5.11 and sets at 6.49.

There is a partial eclipse of the Sun on the 19th, but no part is visible in this country; it is only visible from the Arctic regions and West of Canada. The magnitude of the eclipse is 0·315 (Sun's diameter = 1).

Sunspots, after a period of sparseness, are again fairly numerous; at the time of writing several conspicuous groups are visible on the solar disc.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Aug. 4 ..	12° 0′ E	6° 5′	316 48′
,, 9 ..	13° 55′ E	6° 24′	250° 43′
,, 14 ..	15° 42′ E	6° 40′	184 36′
,, 19 ..	17° 24′ E	6° 53′	118 31′
,, 24 ..	18 58′ E	7° 3′	52° 28′
,, 29 ..	20° 23′ E	7° 10′	346 24′

The Moon:—

Date.	Phases.	H. M.
Aug 4 ..	○ Full Moon	1 0 p.m.
,, 12 ..	☾ Last Quarter	2 48 a.m.
,, 20 ..	● New Moon	1 28 a.m.
,, 27 ..	☽ First Quarter	0 43 a.m.
,, 1 ..	Perigee	6 48 a m.
,, 13 ..	Apogee	5 48 a m.
,, 27 ..	Perigee	9 30 a.m.

There is a total eclipse of the Moon on the morning of the 4th. It is invisible in this country, but visible over part of North America and the greater part of the Pacific Ocean.

Occultations.—The following are the particulars of the occultations visible from Greenwich before mid night:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time	Angle from N. point.	Mean Time.	Angle from N. point.
			h. m.		h. m	
Aug. 4	ι Capricorni ..	4·3	9 3	78°	10 13	260°
,, 5	45 Aquarii ..	6·3	9 40	76	10 50	252°
,, 29	ξ² Sagittarii ..	3·5	6 29	88°	7 43	276°
,, 31	19 Capricorni ..	6·0	6 10	17	6 30	330°

The Planets.—Mercury (Aug. 1, R.A. $9^h\ 46^m$; Dec. N. 9° 3′. Aug. 31, R.A. $9^h\ 26^m$; Dec. N. 15° 12′) is in inferior conjunction with the Sun on the 12th, and hence is invisible during the former part of the month: towards the end of the month the planet is a morning star in Leo, and attains a greatest westerly elongation of 18° 11′ on the 29th. This is a favourable elongation, the planet rising at 3.26 a.m.

Venus (Aug. 1, R.A. $11^h\ 21^m$; Dec. N. 5° 5′; Aug. 31, R.A. $13^h\ 21^m$; Dec. S. 9° 59′) is an evening star in Virgo, and may be observed in the evening sky looking W. immediately after sunset. As seen in the telescope the planet appears gibbous, 0·65 of the disc being illuminated.

On the evening of the 7th the planet will appear in conjunction with the star β Virginis, as shown in the

diagram, the separation being only 15′ at 1 p.m. On this date the planet sets at 9 p.m.

Mars (Aug. 1, R.A. $8^h\ 23^m$; Dec. N. 20° 31′; Aug. 31, R.A. $9^h\ 40^m$; Dec. N. 15° 10′) is a morning star, rising about 3.45 a.m. throughout the month.

Jupiter (Aug. 1, R.A. $6^h\ 1^m$; Dec. N. 23° 8′; Aug. 31, R.A. $6^h\ 25^m$; Dec. N. 23° 2′) rises about 1 a m. on the 1st of the month, and about 11.30 p.m. on the 31st. The planet is situated near the star 1 Geminorum.

Saturn (Aug. 1, R.A. $23^h\ 4^m$; Dec. S. 8° 9′; Aug. 31, R.A. $22^h\ 57^m$; Dec. S. 9° 0′) is an evening star describing a retrograde path in Aquarius. Near the middle of the month the planet rises about 8 p.m., and is on the meridian at 1.30 a.m. We are looking on the northern surface of the ring, the outer major and minor axes of which are 44″ and 3″ respectively, whilst the apparent semi-diameter of the ball is 8″·8.

Uranus (Aug. 15, R.A. $18^h\ 21^m$; Dec. S. 23° 41′), though somewhat low down in the sky, is well placed for observation during the early evening, the planet being due south on the 15th at 8.48 p.m. He is situated a little to the S.E. of the star μ Sagittarii. Uranus is just perceptible to the naked eye. but can easily be seen with a pair of opera glasses. The diameter of the disc is nearly 4″, and the colour is greenish. As seen in large telescopes the planet appears more luminous at the centre of the disc than at the limb—somewhat similar to Jupiter and Saturn.

Neptune (Aug. 15, R.A. $6^h\ 50^m$; Dec. N. 22° 4′) does not rise until after midnight. He is situated about 1° north of the star ζ Geminorum.

Meteors:—

Date.	Radiant.		—
	α	δ	
Aug 10-12	45°	+ 57°	Great *Perseid* shower; radiant moving E.N.E. about 1° per day.
Aug. 21-25	291	+ 60°	ο Draconids; bright slow meteors.

Minima of Algol occur on the 19th, at 0.16 a.m., and on the 21st, at 9.5 p.m.

Mira (ο Ceti) is due at minimum on the 15th, but frequently the phases are retarded; the star varies from magnitude 3·3 to 8·5.

Telescopic Objects:—

Double stars: Polaris, mags. 2·1, 9·5; separation 18″·6. The visibility of the fainter star is frequently used as a test for a good 2-inch object glass.

ζ Sagittæ, XIX.^{h} 45^m, N 18° 53′, mags. 5, 10; separation, 8″·6.

α¹ α² Capricorni XX^h 12^m, S. 12° 15′, mags. α¹ 4·5, α² 3·8; naked eye double, separation 373″, very easy with opera glasses.

Knowledge & Scientific News

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The New Cosmogony.

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

IN Laplace's Nebular Hypothesis, the original mass, from which the solar system was evolved, was supposed to consist of gaseous or meteoroidal material filling a space of spheroidal form and extending to the orbit of the planet Neptune, or somewhat beyond it. If a gaseous state be assumed the whole mass was supposed to be in hydrodynamical equilibrium, and rotating in a period equal to the period of revolution of the present farthest planet. We might also assume that the original mass consisted of a gigantic swarm of meteorites, for Professor G. H. Darwin has shown that such a swarm would have nearly the properties of a gas. On either assumption the mass would contract by its own gravitation, and, the angular velocity gradually increasing, the centrifugal force would in time flatten the spheroidal mass at the poles. From this flattened spheroid Laplace thought that rings would be detached at certain intervals, and these rings consolidating would eventually form the planets and satellites of the solar system as we now see them.

It has been shown, however, by Mr. F. R. Moulton, that the matter detached from the rotating gaseous spheroid would be "shed continually," and that no separate rings could be formed. This would occur whether we consider the original mass to have been gaseous or composed of meteorites. But supposing the rings to have been, by some miracle, detached from the parent mass, we should expect to find that the plane of Mercury's orbit would deviate less than the other planets from the average plane of the solar system; also that the orbits of the "terrestrial planets," Mercury, Venus, the Earth, and Mars, would be less eccentric, that is, more nearly circular, than those of the outer planets. But the known facts concerning Mercury's orbit are quite opposed to these conclusions. The inclination of its orbit to the plane of the ecliptic (7°) is greater than any of the large planets, and the eccentricity of its orbit (0.20) is only exceeded by that of some of the minor planets between Mars and Jupiter. Further, Moulton shows that the distribution of masses among the planets of the solar system indicates that the original nebulous mass must have been very heterogeneous and not homogeneous as Laplace's theory postulates.*

* *Astrophysical Journal*, March, 1900.

There are numerous other difficulties connected with Laplace's Hypothesis, and many attempts have been made to overcome them. But these efforts have proved only partially successful, and for some years past it has become increasingly evident that the hypothesis must be abandoned for something in better agreement with modern telescopic discoveries. The idea that the planets were formed by the condensation of rings detached from a nebulous mass is an hypothesis for which we find no warrant in the heavens. Laplace's idea of a Nebular Hypothesis was probably suggested by a consideration of Saturn's rings. But modern researches on tidal action tend to show that this wonderful system was not originally formed as a ring left behind by Saturn during the progress of condensation from the nebulous stage. More probably the matter composing the rings was originally separated from the planet in one mass. This mass being too close to Saturn to consolidate into a satellite—being within what is known as "Roche's limit"—was torn into fragments by the force of tidal action, and its particles were scattered round the planet in the form of a ring as we now see it. On this view of the matter the course of events was exactly the reverse of what was supposed to have happened in Laplace's Hypothesis. Instead of a ring being first formed, and then a number of small satellites from this ring, we must now conclude that a mass of matter was first detached from the partially consolidated planet, and that then this mass was broken up into small fragments by the enormous tidal action of the central mass.

We see in the heavens numerous forms of nebulæ—spiral nebulæ, planetary nebulæ, etc.—but there is no real example of a ring nebula. Those which have been termed "annular nebulæ" are most probably spiral nebulæ seen foreshortened. Of the numerous nebulæ recently discovered with the Crossley reflector at the Lick Observatory it has been found that "a large proportion are spiral, and that practically all the spirals are lenticular or disc-shaped. Many of them are relatively very thin."* At one time the photographs of the great nebula in Andromeda were thought to show signs of ring formation, but Dr. Roberts, describing his photograph of this wonderful nebula, says: "That this nebula is a left-handed spiral and not annular, as I at first suspected, cannot now be questioned; for the convolutions can be traced up to the nucleus, which resembles a small bright star at the centre of the dense surrounding nebulosity." Even the "ring nebula" in Lyra, which is sometimes adduced as an example of ring formation, was found by Professor Schaeberle, of the Lick Observatory, to be "a two-branched spiral which commences at the central star, and in a clock-

* Publications of the Astronomical Society of the Pacific, Dec. 10, 1904.

wise direction emerges on opposite sides near the minor axis." Even the apparent ring form of this nebula seems to be fictitious. Instead of being annular in shape, it appears to be a hollow spheroid, the ring representing the thickness of the shell. To anyone who still persists in maintaining the theory of ring formation in nebulæ it may be said that the whole heavens are against him.

It has always been difficult to imagine how rings could possibly be formed from the parent mass, considering the extreme tenuity of the original nebula. Computing from the total mass of the bodies composing the solar system, the density of the primitive nebulous mass—supposing it extended to the orbit of Neptune—would have been almost inconceivably small. The density of atmospheric air would be millions of times greater, and how rings could be formed in such a tenuous gas has always been a serious difficulty in the discussion of Laplace's Hypothesis. But a still more fatal objection has lately been found. The original idea was that the detached "rings" would at first break up into separate masses, and that these fragments would afterwards—by their mutual attraction—consolidate into planets. But from a mathematical investigation recently undertaken by the well-known American mathematician, Mr. John N. Stockwell, he finds that if two masses "are moving in the same plane and at the same mean distance from the sun, and are situated at an angular distance greater than 60° and less than 180° from each other, as viewed from the sun, their mutual perturbations will cause them to approach each other until the distance apart becomes equal to 60°"; and, further, if the two masses "are situated at an angular distance of less than 60° apart, as seen from the sun, their mutual perturbations will cause them to recede from each other until their distance apart becomes equal to 60°; and they will always remain in a condition of stable equilibrium at that distance apart, and will revolve round the sun for ever free from mutual disturbance."†

This result seems fatal to Laplace's Hypothesis in its original form, as the fragments of the ruptured ring could never have consolidated into a single planet. Mr. Stockwell adds: "The assumption by Laplace that the matter of which the ring was composed would concentrate by the mutual attraction of its different parts into a single planet or satellite is, therefore, not sustained by a rigorous calculation; and since the Nebular Hypothesis wholly fails to satisfy that requirement it evidently rests on no logical foundation."

Compelled, therefore, as we apparently are, to abandon Laplace's Nebular Hypothesis in its original form, are we, therefore, obliged to relinquish all attempts to explain the formation of suns and solar systems from the consolidation of gaseous matter? By no means. The heavens, which are clearly against Laplace's Hypothesis, are strongly in favour of a new theory, a new cosmogony, which will probably stand the test of mathematical analysis. This is the evolution of suns and systems from spiral nebulæ. Of the half-million nebulæ discovered with the Crossley reflector a large proportion are spiral, and the study of these remarkable and interesting objects will probably form an important portion of the work of future astronomers.

‡ *Nature*, August 6, 1903.

† *Astrophysical Journal*, No. 557, March 4, 1904. An asteroid recently discovered (TG) has nearly the same period and mean distance as Jupiter, and seems to fulfil the conditions supposed by Stockwell. At present it is 60° from Jupiter, and may perhaps remain so.

Laplace's original nebula was gaseous, and a gaseous spectrum shows bright lines. But the spectrum of the spiral nebulæ is *continuous*, indicating that they have partially consolidated from the gaseous state. We can, therefore, easily imagine that masses might be thrown off or detached from the parent mass by the centrifugal force of the rotation. This seems much more probable than the formation of rings from a highly tenuous nebula. Photographs of spiral nebulæ show us masses in the act of being detached from the spiral branches. This is particularly noticeable in the photograph of the great spiral in Canes Venatici (51 Messier), in which we see the process going on before our eyes.

The theory of the evolution of suns and solar systems from spiral nebulæ has recently been investigated mathematically by Professor T. C. Chamberlin and Mr. F. R. Moulton. This investigation consists in an attempt "to test by an appeal to the laws of dynamics the consistency of the ring theory with known phenomena. Contradictions were uniformly found, and in some cases the results were so conclusive as to compel us frankly to abandon it as an untenable hypothesis."* An outline of this new cosmogony, called by Professor Chamberlin the "Planetesimal Hypothesis," and which certainly seems a great improvement on that of Laplace, may prove of interest to the general reader.

The *origin* of the nebulous mass from which the solar system is supposed to have been evolved was not considered by Laplace. He *assumed* its existence, and then proceeded to show, as he thought, how the sun and planets might have been formed from it by the consolidation of the nebulous matter in the course of ages. The origin of spiral nebulæ is, of course, unknown, but of their existence there can be no doubt. Photography has fully confirmed the discovery originally made by Lord Rosse with his giant 6 feet telescope. They are very numerous in the heavens. Professor Keeler thought that probably one-half of the nebulæ found with the Crossley reflector are spiral, and that "any small compact nebula not showing evidence of spiral structure appears exceptional." Spiral nebulæ were, of course, unknown to Laplace, and had he known of their existence we should probably never have heard of "ring formation."

A spiral nebula may possibly have been formed by a "grazing collision" of two solid or nebulous masses, or by the near approach of two bright stars. Supposing the near approach of a large body to another of larger size, the effect on the latter body would be the production of a gigantic tide on the side turned towards the approaching body, and another tide of almost equal size on the *opposite* side. These tides would produce explosions and eruptions of nebulous matter from the interior of the star, and Moulton shows that the ejected material would assume the spiral form. That a spiral form would be assumed by a rotating gaseous mass has also been shown by Herr E. J. Wilczynski, of Berlin.† Now it is a remarkable feature of spiral nebulæ that the spiral branches (usually two) almost invariably issue from the central nucleus at diametrically opposite points, thus agreeing with the new hypothesis. The spiral nebulæ which we see in the heavens are, of course, constructed on a colossal scale, and probably represent a stage in the evolution of star systems rather than solar systems like ours. But the principle would be the same in both cases.

In Chamberlin's "Planetesimal Hypothesis" the original nebulous mass "must have spread out in the

* *Astrophysical Journal*, October, 1905.

† *Astrophysical Journal*, Vol. 4 (1896), p. 98.

form of a relatively thin disc," and instead of being homogeneous, as in Laplace's Hypothesis, "it may have had almost any degree of heterogeneity." In this theory fluid pressure, which was of fundamental importance in Laplace's Hypothesis, is of minor consideration, "and no general shrinkage with loss of heat" plays any part in the evolution of planets from the parent mass.

Moulton shows that on this theory the resulting planets will all probably revolve round the nucleus in the same direction as the original rotation, and that the also agrees with the known facts of the solar system. The orbits of the so-called "terrestrial planets," Mercury, Venus, the Earth, and Mars, are, on the average, more eccentric than those of the large planets, Jupiter, Saturn, Uranus, and Neptune; and those of the small minor planets between Mars and Jupiter are still more so.

With reference to the rotations of the planets on their axes, Moulton shows that these would probably be direct, that is, in the same direction as the orbital revolutions, and that the inclinations of the axes of

The Spiral Nebula, 51 Messier.

(*From a Photograph by W. E. Wilson, F.R.S.*)

planes of their orbits "will nearly, though not exactly, coincide"; also that the orbits of the larger planets will show smaller deviations from the general plane than those of the smaller planets, like Mercury and the asteroids. This we know to be the case in the solar system. He shows that the present rotation of the sun is due to the original rotation of the mass from which it was formed, combined with the disturbance caused by the body which approached it, and that the more rapid rotation of the sun's equator is due to the same cause. He also shows that the larger the planet "the more nearly circular in general" its orbit would be; and this rotation to the planes of the orbits might be different for different planets. Any well-marked deviation from this rule might be expected in the outer planets of the system. This we see in the case of Uranus and Neptune, which have always proved stumbling blocks in Laplace's Hypothesis. We should also expect, he thinks, "to find the larger planets rotating more rapidly than the smaller," and this we know to be the case.

With reference to the satellites, the direction of their motion round the primary might, on the new hypothesis, be either direct or retrograde, according to circumstances. Retrograde motion might be expected in satellites very remote from their primary and revolving in orbits of high eccentricity. This is the case with Phœbe, the recently-discovered ninth satellite of Saturn. The position of the satellites of Uranus could not have been predicted by the new theory, but Moulton thinks that "they do not definitely contradict it as they do the ring theory."

A satellite might also, on the new theory, revolve more rapidly round its primary than the primary rotates on its axis. This is the case with Phobos, the inner satellite of Mars, which revolves round the planet in 7 hours, 39 minutes, 15 seconds, while Mars' period of rotation on its axis is 24 hours, 37 minutes, 22.66 seconds, or over three times as long. This unusually rapid rotation of a satellite formed another objection to Laplace's Hypothesis, but it seems to be consistent with the new cosmogony.

With reference to the so-called "moment of momentum" of the solar system, Professor Chamberlin has shown that the greater portion belongs to the planets, and that Jupiter alone contains about 95 per cent. of the moment of momentum of the total mass within the orbit of Saturn. This is, according to Moulton, "an inevitable consequence of the spiral theory, but, on the contrary, the whole question of the moment of momentum is a rock on which the ring theory breaks."

According to the new cosmogony the outer portions of the matter ejected from the original body would evidently be formed from the surface portions of the star, while the matter which followed would "come mainly from lower depths," and would probably consist of materials of greater density. The smaller planets should, therefore, be cool and of high density, and the larger planets hot and of small density. This is also in agreement with the known facts of the solar system. The average density of Mercury, Venus, the Earth, and Mars is about $4\frac{1}{2}$ (water = 1), while the mean density of Jupiter, Saturn, Uranus, and Neptune is only 1.03, or about that of water. We know that the earth is cool, and that probably Mercury, Venus, and Mars are so also, while there is good reason to suppose that the large planets are in a highly heated condition.

On the whole, Moulton concludes that "the spiral theory is even now a good working hypothesis." It seems to explain satisfactorily all the observed phenomena upon which the ring theory was based, and many others which are in contradiction to Laplace's original hypothesis. "Nothing has yet been found which seems seriously to question its validity."

The new cosmogony will, of course, raise many very difficult questions in celestial mechanics, and will give a considerable amount of work to mathematical astronomers before it can be placed upon a satisfactory basis; but the work which has been already done by Chamberlin and Moulton shows clearly that the spiral theory is far superior to Laplace's Nebular Hypothesis, which should now be definitely abandoned and consigned to the limbo of unproved theories. The heavens show us thousands of spiral nebulæ, which are evidently in a state of rotation round a central nucleus, but which will probably take ages before they have finally consolidated into suns and solar systems. But ages are but moments in the evolution of the stars, and we need not expect to find much evidence of rotation and consolidation during the brief span of human history. Empires rise and fall, dynasties are founded and dissolved, but the heavens move on in their silent course, and the human race will probably have perished before the universe has reached its final destiny.

The Study of the Cell in the Higher Plants.

By H. A. Haig.

(Continued from page 517.)

Shortly after the appearance of the spirem stage, the long thread of chromatin breaks up into separate threads, the number of which is constant for any given plant; these threads then take on the form of "loops,"

Fig. 6.

that is, become bent on themselves, and travel towards the central part, or equator, of the spindle, where they become arranged as a definite rosette, with the bends towards the centre, which, seen in optical section in a longitudinal section, has the appearance of a dark, central, transverse mass, with projecting portions on either side (see Fig. 6). This is consequently known as the single rosette, or "monaster" stage. A most important change now takes place, in that each of these loops splits longitudinally into two equal loops, and the bends of these separate from one another, so that we have finally two systems of loops, arranged so that their bends are remote from, and their free ends adjacent to, one another, each system preserving the general rosette arrangement.

In the next phase observed, these separate systems are travelling away from one another, and the appearance we get is that shown in Fig. 7, which represents this stage in one of the cells of the root-tip of the water-lily, with a more advanced stage in an adjacent cell. It will be seen that the loops are more or less symmetrically arranged with regard to the spindle.

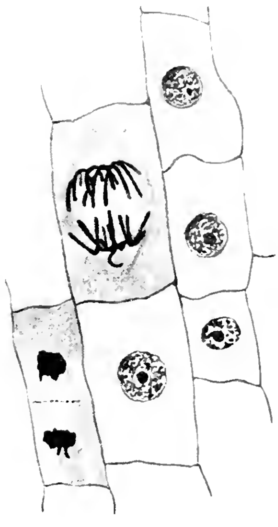


Fig. 7.

When the loop systems have reached the opposite poles of the achromatic spindle, the stage known as the "diaster" stage is reached, and each of the loop systems then undergoes a series of inverse changes, *i.e.*, the loops lose their symmetrical arrangement, become thinner, and join up to form a spirem (dispirem stage), which finally breaks up once more into separate masses of chromatin, which become arranged upon a previously formed linin network. During these latter phases, the "cell-plate," or rudimentary partition wall, arises in the median equatorial plane of the nuclear spindle. Small thickenings appear at the middle points of the separate threads of the spindle, and these finally coalesce to form a well-marked cell-plate. We have before remarked that this is probably an instance of a direct transformation of kinoplasm into carbohydrate (cellulose).

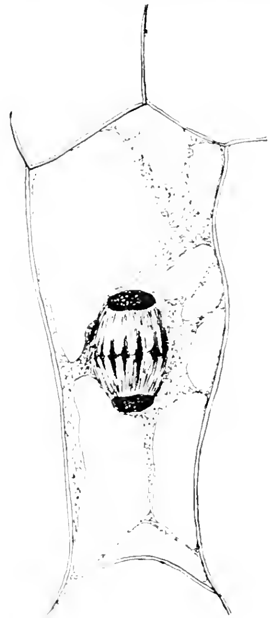


Fig. 9.

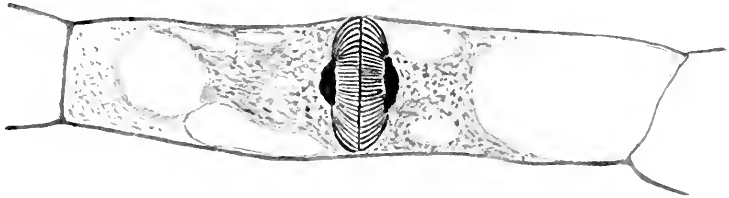


Fig. 8.

The later stages and the formation of the cell-plate are well shown in Figs. 8 and 9. Fig. 9 is from a photo-micrograph and the equatorial thickenings on the spindle-fibrils can be easily distinguished; the daughter-nuclei become further differentiated by the development of fresh nucleoli, and the possible resumption of a nuclear membrane.

It is in this manner that new cells are formed by the process of karyokinesis; and we see that it is a method whereby a very accurate redistribution of chromatin takes place for the formation of equal daughter-nuclei in each of the freshly formed cells. The process has been gone into somewhat fully on account of its importance. We pointed out some way back the fact that economy was carefully attended to in the higher plants, and we have here a means whereby each fresh cell is appointed equal quantities of nuclear substance, so that each cell has equal chances of still further division, granted the necessary conditions of an adequate supply of food-materials, including water and oxygen. We see, moreover, what an important structure the nucleus is in the case of these cells of the higher plants; whereas, in those lower plants in which cell-division takes place without mitosis, the nucleus seems to take a less important place, although it may still possess a very definite function as regulator of nutrition or a cell-centre of some sort.

4.—The further modification of a cell, as dependent upon its position, and the ultimate function it has to fulfil.

The several tissues of which a plant is made up, such as the assimilatory, conducting, and reproductive, are characterised to a certain extent by the form and functions of their component cell-units. It is not intended here to go into a detailed description of the microscopical features presented by these various types, but rather to try and elucidate some of the causes which determine the wide divergencies from the simple form which can be effected in a living cell.

The mass of embryonic tissue in a young bud, or at the apex of a rapidly growing stem, is mainly composed of the kind of cell we started by examining in this article, *i.e.*, one in which we can recognise cell-wall, protoplasm filling the cell-cavity, nucleus and plastids. Each of these cells is capable of active division, and, up to a certain point, maintains its simple characteristics. But a little way distant from the apex, towards the central parts of the young tissue—in other words, the outer boundary of that portion of the young axis known as the "plerome"—we find certain of these cells undergoing elongation, thickening of their cell-walls with characteristic markings on them, and a gradual diminution in protoplasm and other cell-contents. The cells, in fact, are becoming slowly converted into vascular elements continuous with those of the main stem, and the causes determining this transformation are partly dependent upon the position of these cells, partly upon the nature of the food-materials supplied, and in part, perhaps, upon a certain inherent capacity possessed by the protoplasm in these regions. That this capacity in any given part admits of modification, is seen in the case of a formation of adventitious organs (such as roots) from cuttings taken from species of begonia and other plants, an entire plant being in this way reproduced; and in cases like this we see the effect which sudden change has upon the various parts of a plant, and the great adaptability of protoplasm to altered conditions of existence. Position is, to some extent, a factor in the determination of function, as a given cell is surrounded by others of the same tissue, which can influence, and perhaps regulate, its metabolism. But there are a few apparent exceptions to this, as in the case of cells known as "idioblasts"—that is, cells more or less different in structure and functions from those by which they are surrounded. Such are tannin-cells, cells of oil-glands, and those in which large masses of crystals sometimes separate out. It would seem here as if the protoplasm of a given cell were capable of modifying its action in such a way as to take on the additional or sole function of manufacturing substances, which may or may not be of future use to the plant; but as to why protoplasmic action should in these cases be modified is difficult to explain, and explanation would only become possible on the theory of the mutual inter-dependence of cells.

In the embryo-plant, certain rudimentary tissues are laid down, such as those composing radicle, young stem, and leaf rudiments; there are grounds for assuming that the formation of these embryonic organs is governed to a certain extent by a hereditary influence transmitted with the protoplasm, from which the cells composing these organs are ultimately produced. Later on, when external surrounding conditions begin to act upon these cells, we find that the hereditary influence loses to a certain extent its value, and the further modification of the cell depends more and more upon these conditions and upon the final position relative to other tissues which it takes up.

We find in some cases that hereditary characters are retained up to a certain point, but that these characters tend slowly to become modified, even to complete absence, by the predominant effect of other conditions; such an instance we find in prefertilisation stages in the embryo-sac of the Angiosperms, where the antipodal cells formed during the divisions of the nucleus of the embryo-sac represent a former prothallium, thus showing to a certain degree a relationship of the Angiosperms with the Gymnosperms, and Cryptogams. But the cells of this prothallium are now so reduced and few in number that, in time, they will probably be non-existent.

We cite this case simply to show that hereditary influences are at work during embryonic stages, and that we must not lose sight of this possibly important factor in cell-modification. The cell, however, is modified in the various parts of a plant in order to be able to fulfil certain functions, and this change is completed when the various organs have, under the influence of external conditions, attained their perfection. As to the causes of this modification, we have seen that some may have their origin in a certain hereditary capacity impressed upon the cells of an embryo-plant, and yet others are certainly due to the influence exerted by surrounding conditions. Some remanent hereditary capacity must likewise be assumed to be present even in the protoplasm of cells of even highly developed organs, so that we must not think subsequent modification during growth entirely due to external conditions.

Moreover, it is important to remember that the adaptability of protoplasm is limited to young cells, for a cell that has been already modified to a certain extent will probably, even if placed under entirely new conditions, proceed upon the same lines of development as before, or else be unable to exist at all under these altered conditions.

Having now examined the cell under the four headings set out at the beginning of this article, we must further try and gain an idea of the general working of the cell looked at from the point of view of a unit depending upon the existence of other cells, as well as upon its own labours. By means of the various tissues into which a plant may be divided, a very accurate division of labour is effected; some of the work done by living cells is manifested in the formation of units that soon become devoid of protoplasm, such as in the wood of stem and root, but these elements have a very definite function, *i.e.*, as water-carriers from the root upwards. Of the cells that remain living units throughout their whole existence, some are set off as assimilators of carbon from the atmosphere, others as the further elaborators of this carbon into substances, such as sugar and starch, that can be later made use of by the cells. The cells set aside for reproductive purposes arise in parts of plants specially constructed for this, and the origin of these cells is to a large extent governed by hereditary influences, and partly by certain peculiarities in nutrition. Their further behaviour is also upon definite lines, and the formation of the egg-cell, the influence of fertilisation, and the whole of the phenomena concerned in the production of the embryo point strongly to the influence of heredity.

The dependence of any one part of a plant upon any other is easily seen in the fact that the leaves and other green portions of a plant are the only organs in the higher plants (speaking generally) whereby carbon is assimilated, and without the leaves the plant would certainly die. Likewise the dependence upon the roots for the greater part of the water taken in is another instance of the same principle.

The cells of the leaf manufacture from raw-materials supplied from below, together with carbon obtained from the carbon dioxide of the atmosphere, the substances needful for the nutrition of the protoplasm in other parts of the plant; the leaves are dependent for their water and salts upon the roots, which take in these from the soil outside, and upon the wood, by the mechanical action of which, aided by root-pressure and the transpiration current,* the water and salts are conducted. By taking instances such as these, it may easily be shown that the various cells of a plant are more or less dependent upon one another, and work towards the same end, namely, the adequate growth and extension of the whole organism, until such time when the reproductive organs have developed and made good the certainty of extension of the species.

Moreover, the instances of transmission of stimuli which we have already studied show us that a very delicate and rapid means of response exists in some cases, which in the Sundew and others is of the highest importance to nutrition, and the reaction of certain parts of plants to injury, by the formation of cushions of callus, whereby injurious evaporation is prevented, is a well-known example of the working of special cells for the benefit of the whole community.

Thus, by an examination of the individual cell, and by the employment of certain biological reasons which are found to hold good and tally with results obtained by experiment, it is possible to gain a little insight into the manner in which the cell works; we see that protoplasm is the working substance, that external stimuli produce measurable effects, and that growth as a whole depends upon the results of these stimuli.

There are undoubtedly many undiscovered factors at work tending to produce the final result, and some of these, it is to be hoped, will be elucidated by future investigations. At the same time it must be remembered that here we have only attempted to give an outline of the value of the cell to the organism; but that such an outline is indispensable if we wish to enter into further investigations.

* The transpiration current is brought about chiefly by the evaporation of water from the leaves; this starts a sort of osmotic action, water being drawn up from lower cells of progressively decreasing concentration

The Study of Heredity.

Although some of the phenomena of heredity have been familiar to us for so long, our acquaintance with them has really been of a very superficial kind. It has been recognised that in general the offspring tend to resemble their parents, and by observation of large masses of individuals we have even been able to arrive at a measure of the strength of this tendency; but of the inheritance of some character in individual cases almost nothing has been known. It is only within the last few years that the attempt to formulate "laws," such as will give a concise description of the observed phenomena, has met with any success.

The object of this article is to give an account of the principal methods by which the work has been carried on, and briefly to indicate some of the principles upon which the study of heredity is based, without attempting to enter at all fully into the details which must be sought in more technical papers. There exist at the present time two schools, which attack the problem from very different standpoints and by very different methods of investigation.

The Statistical Method.

The foundation for the work of the present school of Biometricians was laid by Francis Galton when he applied the methods of statistics to the treatment of the phenomena of heredity and variation.

A series of observations is made upon some one character throughout a very large number of individuals of some race. The character chosen is susceptible either of quantitative measurement or of reference to some group in a qualitative scale. The stature and the eye-colour of man may be cited as instances of two characters which were studied, among others, by Galton.

The measurements are carried out upon a large number of individuals taken at random from among the general population. The results are arranged in a table showing the number of individuals which come under each degree of our scale, and may be represented graphically by plotting on squared paper the vertical ordinates representing the number of individuals who possess the character in the degree indicated by the corresponding abscissæ.

The larger the number of measurements the nearer the tops of the ordinates are found to approximate to a smooth curve. The character which is borne by the largest number of individuals, that is, which corresponds with the highest point of the curve, is known as the mode; and the curve will be one of three general types according to the position which the mode occupies. The mode may be median, the curve being symmetrical about the mean character; it may be nearer either end of the curve, representing graphically the fact that divergence from the mode in one direction is more common than in the other; or, finally, the curve may show more than one peak, the intermediate values occurring less frequently. This curve represents a population which may be divided into two or more groups, each with its own mode. Intermediate forms are rare, so that there is generally no difficulty in placing any individual in its proper group. Variation of this type is known as "discontinuous," as opposed to the continuous variation represented by curves of the first two types.

The range of variation of the character throughout the race is represented by the length of the base line upon which the curve is erected. The frequency with which any variation within that range occurs will be at once seen to depend upon the shape of the curve, its steepness, &c. Suppose M to be the mean value of the character as represented in our race; then the measure of the character in any individual may be written M + D where D is the *deviation* of the character from the mean value for the race in that individual. The mean value of the squares of *all* the individual deviations represented in the curve is the square of a factor known as the *standard deviation*, which gives a measure of the variability of the character in the race under observation. Observation shows that, in general, related individuals tend to resemble one another, in regard to some one character, more nearly than they resemble all the other individuals of the same race. This resemblance between the characters of related individuals is a case of *correlation*. It is found, moreover, that if one individual possesses the character in a certain degree, there is a "most probable value" for the same character in his relations. Inspection of the curve will suggest to us that in general this "most probable value" will lie between the value of the first chosen individual and the mode. This is found to be the case, and this phenomenon is known as *regression*.

Regression and correlation may be represented graphically by plotting the values of the first chosen individuals with the mean values for some one group of relations, say, for their brothers, or for their sons.

If the corresponding values which are plotted together are identical the curve will form a diagonal to the square, correlation will be complete, and regression will be absent; but if, as is always the case, correlation is only partial, the curve will form an angle with the diagonal which represents complete correlation, the angle being greater the less the correlation and the greater the regression are. The slope of this line gives a measure of the correlation known as the "coefficent of correlation," which is taken as unity in the hypothetical case where correlation is complete. In practice the coefficient of correlaton is always a positive fraction less than unity.

The numerical expression for correlation and regression thus obtained may be applied to the special case in which the relation between the first-chosen individual and the group of relatives is that of parent and offspring. The character of the parent being known, the coefficient of correlation and the standard deviation for the race may be used to obtain a value for the probable character of the offspring, that is, a value to which the mean of the values for all the offspring will approximate more and more nearly as the number of offspring is larger and larger.

The same method may be applied to the case of biparental inheritance, when we require to find the probable character of the offspring, taking into account the known characters of both parents. Taking as our example the case of the stature of man, it will be noticed at once that the greater mean stature of the males, as compared with that of the females, introduces a factor for which allowance must be made. Men are, on the average, taller than women, hence in calculating the probable stature of sons from the known statures of the father and mother, a correction must be applied to the observed stature of the mother.

Galton showed how this might be done by replacing the observed stature of the mother by a value representing the equivalent stature for the male. Prof. Karl Pearson has shown that in general the probable character of the offspring may be calculated by the use of what is known as a "mid-parent"; that is, a single artificial parent whose characters are calculated so as to combine those of the father and of the mother into one.

From the study of biparental inheritance by means of the method indicated above we may pass directly to the "Law of Ancestral Heredity," which, first formulated by Francis Galton, has been somewhat modified and extended by Karl Pearson. In this law, use is made, not only of the correlation between offspring and parent, but of that between offspring and grandparent, and between offspring and more remote ancestors, in order that the probable character of the offspring may be calculated with the greatest possible approximation to the truth.

By means of the method already mentioned a "mid-grandparent" is formed from the four grandparents; a "mid-great-grandparent" from the eight great-grandparents, and so on for the more remote ancestors.

Now it is obvious that as the generations are traced backwards the ever-increasing number of ancestors will, except in extreme cases of in-breeding, approximate more and more closely towards a fair sample of the whole population at that period, so that the mid-parent of, say, the 10th generation, will show little or no deviation from the racial type of that period.

Francis Galton's "Law of Ancestral Heredity" was the first attempt to give a numerical expression which should indicate the proportion in which each generation of the ancestry contributes to the characters of an individual.

The Law was enunciated thus: "Each parent contributes, on an average, one quarter or $(0.5)^2$, each grandparent one-sixteenth or $(0.5)^4$, and so on, and generally the occupier of each ancestral place in the nth degree, whatever be the value of n contributes $(0.5)^{2n}$ of the heritage." These numbers form a geometrical series, of which the sum of an infinite number of terms is unity. Professor Pearson has shown that some modification of this statement is necessary, and has introduced a quite general mathematical expression for the Law of Ancestral Heredity, which avoids certain assumptions made in Galton's enunciation of the law. For the particular case assumed by Galton, the original series of factors would be replaced by the series

$$0{\cdot}3,\ 0{\cdot}15,\ 0{\cdot}075,\ 0{\cdot}0375\ \ldots\ {\cdot}6 \times (\tfrac{1}{2})^n$$

for unions where the sexes are equipotent, blend their characters and mate pangamously.

Want of space compels us to turn now to the second part of our subject. The previous pages have given no more than the briefest outline of the methods adopted in the statistical treatment of heredity. I would suggest that any readers who may wish to make themselves more familiar with the subject should refer to Prof. Pearson's book, "The Grammar of Science," in which the theory is simply explained, and to numerous publications of the same author in the *Transactions of the Royal Society*. Further information may be obtained in "Biometrika" (Camb. Univ. Press), a journal in which the results obtained by the statistical method are published from time to time.

The Mendelian Hypothesis.

It was as long ago as 1865 that Gregor Mendel, who was then Abbot of Brunn, communicated the results of his experiments in plant hybridisation, which he had pursued for eight years previously, to the Brunn Society of Naturalists.

For 35 years his work, although of such fundamental importance, remained entirely unrecognised, until in 1900 it was rescued from its obscurity by the simultaneous discoveries of de Vries, Correns, and Tschermak. It was mainly by the simplicity of his experiments, in which the inheritance of some particular character was traced through several generations, that Mendel was able to arrive at the hypothesis which has revolutionised our conceptions of the physiology of heredity. Mendel's work was carried out by means of artificial fertilisation in a race of plants chosen, after careful preliminary work, as suitable for the purpose for which it was used.

"The experimental plants must necessarily :—

"(1) Possess constant differentiating characters.

"(2) The hybrids of such plants must, during the flowering period, be protected from foreign pollen, or be easily capable of such protection.

"(3) The hybrids and their offspring should suffer no marked disturbance in their fertility in the successive generations."*

Such plants Mendel found in the Garden Pea (*Pisum sativum* and its varieties). From among the many varieties of peas he chose pairs of varieties, for artificial cross fertilisation, in such a way that the members of each pair differed from one another in some one definite character. The characters selected for experiment were :—(1) The shape of the *ripe* seed, whether round or deeply wrinkled; (2) the colour of the cotyledons in the *ripe* seed (*i.e.*, the colour of the seed *after* the removal of the seed coat); whether green or yellow; (3) the colour of the seed coat, whether white or some shade of brown; (4) the shape of the ripe pod, whether simply inflated or deeply contracted between the seeds; (5) colour of the unripe pod, whether green or yellow; (6) the position of the flowers, whether distributed along the stem, or crowded near the top; (7) the length of the stem, whether 6 to 7 feet or $\frac{3}{4}$ to $1\frac{1}{2}$ feet.

Each pair of the above characters were united by cross fertilisation. Mendel found that in each case one only of the two characters appeared in the hybrid offspring, the hybrid character resembling that of one of the parental forms so closely that "the other either escapes observation completely, or cannot be detected with certainty. This is found to be true whichever variety be used as the seed parent; that is, reciprocal crosses give identical results." The character which thus appears was termed by Mendel the *dominant*, the character which is hidden being the *recessive*.

The next generation is obtained by self-fertilising these hybrid plants. The result of this is that in these peas the offspring, instead of being all alike, break into two forms, resembling respectively the two parental forms. The ratio in which these two forms are obtained is, within the error of observation, that of three dominants to one recessive.

Take, for example, Mendel's second experiment of crossing two varieties differing from one another in the colour of the cotyledons. The cotyledons are, of course, the first leaves of the young plants, so that this particular cross has the advantage that the characters of the offspring can be determined in the same season that the cross is made.

Mendel made 58 crosses, yielding 253 seeds, all of which had yellow cotyledons. R. P. G.

To be continued.

* Bateson's translation of Mendel's original paper. See "Mendel's Principles of Heredity." Camb. Univ. Press. Page 42.

The Origin of Birds.

By W. P. Pycraft, A.L.S., F.Z.S.

That birds and reptiles, in spite of their apparent differences to-day, are really very closely allied, admits of no dispute. A comparison of the skeletons alone of the two types would be sufficient to demonstrate this, while the brain, vascular, and urino-genital systems furnish no less striking testimony. But, apart from the indubitable evidence to be obtained from living birds, other and even more striking testimony is to be obtained from the remains of fossil forms.

This evidence carries us back to Jurassic times, the oldest known fossil bird—Archaeopteryx—having been obtained from the lithographic slate of Solenhofen, in Bavaria.

This bird more nearly resembles the reptiles than any other known form. So much so, that undue and unwarrantable use has been made of the fact, many writers having endeavoured to show that it was more reptile than bird, a contention which becomes ridiculous when the facts are carefully considered. Two specimens of this remarkable bird only are known—belonging to as many species—the first to be discovered being now in the British Museum, the second, and most perfect, in the National Collection of Berlin. With the specific distinctions we have nothing to do here, but both agree in having the jaws armed with teeth, and a long, tapering, lizard-like tail; but this, like the rest of the body, bore feathers.

One of the "Pro-Aves."

Of all the accounts that have been given of this patriarch of the bird world, only one can be regarded as accurate, though on many occasions one or other of them have been described by men whose powers of interpretation have in other ways been more severely tried. It is on their descriptions that the inaccurate and sometimes grotesque figures which adorn text-books of comparative anatomy and natural history have been based. So profoundly impressed do these authorities appear to have been by the presence of teeth in the jaws, the long tail, the armature of claws on the wings, and the fact that traces remain only of the wing and tail feathers, and of the feathers of the legs, that they contended that these ancient types must have been clothed, as to the head, neck, and trunk, with scales, and as to the rest of the body with feathers. A contention as wildly improbable, surely, as it would be to insist that, from the absence of all traces of muscles, these primitive creatures had not yet acquired muscular tissue.

Nevertheless, we have, in this primitive type, not only a remarkable link in the chain of evidence as to the source from which birds derived their origin, but also a most valuable key to some essentially avian characters which would otherwise have had to be explained on mere conjecture.

Notwithstanding, then, the unmistakable evidence of reptilian descent furnished by these two fossils, we must await the discovery of yet earlier fossils before we can obtain any certain evidence as to the character of the incipient birds—the pro-aves. Meanwhile, we venture to make a forecast as to the probable appearance of these ancestral types. But all our inferences in this matter must be inspired by, and based upon, that strange, kite-tailed form, Archæopteryx.

From what we know of other types of vertebrates we may safely assume that these ancestral birds were of small size, and were probably also arboreal. And from the unmistakable signs of the shortening of the body in modern birds, the trunk was also relatively longer, as it certainly was in Archæopteryx. From these two inferences we may conclude, with some degree of probability, that these creatures, these birds "in the making," had substituted leaping for climbing about the trees. And from this there was but a short passage to leaping from tree to tree. In these movements we may reasonably suppose the fore-limbs were used for grasping at the end of the leap. The use of the fore-limb for this work would naturally throw more work upon the inner digits—1-3—so that the work of selection would rapidly tend to the increased development of these, and the gradual decrease of the two outer and now useless members. Correlated with this trend in the evolution, the axillary membrane—the skin between the inner border of the arm and the body—became drawn out into a fold, while a similar fold came to extend from the shoulder to the wrist, as the fore-limb, in adaptation to this new function, became more and more flexed. While the fingers, upon which safety now depended, were increasing in length, and growing more and more efficient, they were, at the same time, losing the power of lateral extension, and becoming more and more flexed upon the fore-arm. And the growth in this direction was probably accompanied by the development of connective tissue and membrane along the hinder, post-axial border of the whole limb, tending to increase the breadth of the limb when extended preparatory to parachuting through space from one tree to another, long claws being used to effect a hold at the end of the leap.

The hind limbs, though to a less extent, were also affected by the leaping motion, resulting in the reduction of the toes to four, and the lengthening, and approximation of the metatarsals 2-4 to form a "cannon" bone.

The body clothing at this time was probably scale-like, the scales being of relatively large size and probably having a medium ridge, or keel, recalling the keeled scales of many living reptiles. Those covering the incipient wing, growing longer, would still retain their original overlapping arrangement, and hence those along the hinder border of the wing would, in their arrangement, simulate in appearance and function the quill feathers of their later descendants. As by selection their length increased, so also they probably became fimbriated, and more and more efficient in the work of carrying the body through space.

There is less of imagination than might be supposed in this attempt at reconstructing the primitive feather, inasmuch as there is a stage in the development of the highly complex feather of to-day which may well represent the first stage in this process of evolution. Creatures such as are here conjured up would bear a somewhat close resemblance to Archæopteryx, and it is contended that the discovery of earlier phases of avian development, phases preceding Archæopteryx, will show that this forecast was well founded. But in Archæopteryx, it is to be noted, the feathers differ in no way from the most perfectly developed feathers known to us.

While the external form and mode of life of these primitive, hypothetical types was slowly changing, no less fundamental progress must have been taking place with regard to the internal organs, more especially the nervous, respiratory, and vascular systems, and changes in the direction of a larger brain and a more perfect system of oxygenating the blood. This last was effected by the acquisition of a four-chambered heart, an approach to which has been made only in the living crocodiles among the reptiles. With the addition of this fourth chamber the high temperature and phenomenal activity of the birds came into being, but for reasons for which no explanation is yet forthcoming, the reptilian character of the blood corpuscles was, and is, retained. That is to say, the red corpuscles still retain the nucleus in common with all the lower vertebrates, while in the warm-blooded mammalia—also of reptilian descent—these nuclei have been lost.

But whether these pro-aves are to be regarded as descended, in common with the reptiles, as a collateral branch of the same stock, or whether they sprang from some primitive but true reptile is a point too subtle for present determination.

CORRESPONDENCE.

Red Hills Exploration Committee.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Presumably many of your readers who reside within a few miles of the East Coast are acquainted with the patches of burnt earth, scattered along the margin of many creeks and saltmarshes, especially in Essex, and generally known as "Red Hills."

Their origin, date, and purpose have formed the basis of many a debate, and brief accounts of some of them have from time to time been published, but no satisfactory solution has yet been found of the varied problems they present to a wide range of students.

A Committee has now been formed under the auspices of the Essex Archaeological Society and the Essex Field Club for the systematic study of these interesting relics of antiquity and the settlement, if possible, of the many questions relating to them.

As a first step, a complete list of Essex examples will be prepared and their positions marked on a map which will be published if funds permit.

As the questions to be investigated are not purely archaeological, but touch the wide fields of geological conditions and physical changes, it seems desirable to make the proposed exploration generally known.

It is hoped that the Society of Antiquaries of London will make a grant in aid, but further assistance will be very welcome, as the Committee's operations will necessarily be limited by the amount of funds available.

The Committee consists of the following:—F. Chancellor, F.R.I.B.A.; Miller Christy, F.L.S.; William Cole, F.L.S.; Rev. J. H. Curling, B.A.; W. H. Dalton, F.G.S.; T. V. Holmes, F.G.S.; Dr. H. Laver, F.S.A.; Dr. Philip Laver; Prof. R. Meldola, F.R.S.; Chas. H. Read, F.S.A.; Col. O. E. Ruck, R.E.; F. W. Rudler, I.S.O., F.G.S.; H. Wilmer, C.E., Hon. Sec. and Treasurer.

I. CHALKLEY GOULD, F.S.A.,
Chairman of Committee.

Royal Societies' Club,
London, S.W.

The Renowned Horn of Ulphus.

IN the vestry of York Minster is preserved the horn of Ulphus, which is of ivory, curiously carved, and was formerly ornamented with gold mounting. It is a valuable relic of ancient art, and dates back to a period before the Conquest. An inscription in Latin, on the horn, states that Prince Ulphus gave it to the Church of St. Peter with all his lands and revenues.

Ulph was the son of Thorald and lord of the greater part of Eastern Yorkshire. Tradition says that this Saxon Prince piously presented all his lands to God to hinder his two sons from quarrelling about their possessions. The gift was accompanied with the ceremony of kneeling at the altar rails and drinking the

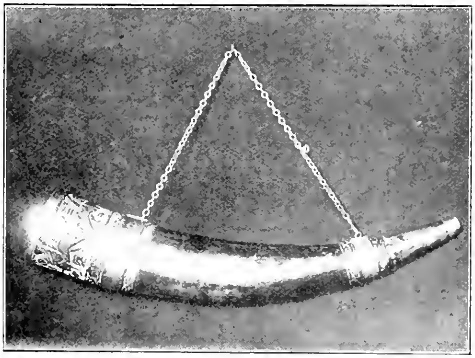


Photo by Duncan & Lewin, Minster-Gates.

The Horn of Prince Ulphus in York Minster.

wine with which he had filled the horn. He then laid and left it on the altar, by tenure of which his lands were held by the Abbey.

Encircling the wide end of the horn is a belt of carving representing griffins, a unicorn, a lion devouring a doe, and dogs wearing collars. The griffins stand on either side of a tree, recalling the sacred tree of Assyrian sculpture.

During the Civil Wars, the horn disappeared, but was afterwards found by Lord Fairfax, whose son restored it to the Minster. The golden ornaments had been stolen, but a silver-gilt chain and bands were attached to it by the Chapter in 1675.

Electrical Nitrates and Fertilisers.

AT present the world's wheat supply depends chiefly on the continued productiveness of a strip of territory in Chili, which produces the Chili saltpetre that serves as a fertiliser. It is the aim of commercial chemistry to produce an artificial fertiliser which can compete with this substance, and for 15 years at least chemists have been trying to find some way of cheaply "fixing" the inexhaustible nitrogen of the air, so as to combine it into a substance that will be an "artificial nitrate." Experiments were first made at Niagara, because electricity was cheap there and the method of making artificial nitrates which first suggested itself to chemists was that which has an analogy to the lightning flash. The lightning as it passes through the air burns the nitrogen and oxygen together so as to leave behind it a streak of nitrous acid, or by burning up the water vapour, a streak of ammonia. Could not the electric arc or spark do the same? So the chemists, Bradley and Lovejoy at Niagara, Birkeland and Eyde in Norway, Rossi in Italy, and Ehrlwein on behalf of the restless experimenting firm of Siemens and Halske, have tried by using electricity, sometimes to form a great number of sparks in a chamber filled with nitrogen, sometimes by using one very large arc, to burn or concentrate this nitrogen into a nitrate, and then (generally), while in this form, to unite it with some basic substance. They have had a greater or smaller measure of success, limited by the cost of their productions; and their methods are described in a valuable summary by Professor Kennedy Duncan. But the goal of commercial success can only be reached through cheapness; and the electrical energy costs too much for the amount of electro-chemical manure produced. Is there any other way? Professor Adolph Frank says there is. He proceeds by the calcium method, which is to force the nitrogen to unite with this metal, one of the few substances in nature with an affinity for nitrogen. By heating red-hot calcium carbide he found it could be got to unite with the nitrogen of the air to form a substance called calcium cyanamide; and calcium cyanamide—to examine its properties no further—can be used as a fertiliser, and is a good one. The fertiliser of the future, then, may be calcium cyanamide, the price of which depends on calcium carbide. The price of both depends, again, on the cost of the electrical energy used in their manufacture; but this method produces by-products in such numbers and variety that the cheapness of production may be said to grow daily.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Self-Recording Instruments.—An apparently very advantageous method of using sensitive paper in self-recording instruments is described by R. Nimfuhr. Printing-out paper is used, and first smoked by the flame of a paraffin lamp, so that the needle point in moving against it traces a line in the soot and lays bare the surface of the paper. The record is then exposed to light to darken the exposed parts, washed to remove the soot, and fixed. The method is stated to work excellently, giving the finest lines. The smoking should present no difficulty if the paper is kept meanwhile in close contact with a metallic surface. The use of a printing-out instead of a development paper very much reduces the precautions necessary in its manipulation with regard to light, and the protecting layer of soot renders the arrangement practically independent of light and unaffected by it.

Snap-Shots Indoors.—The absurdity of trying to get negatives with rapid shutter-exposures inside ordinary buildings has often been commented on, yet it may be possible, and an illustrated article by Mr. Arthur Payne, published a few weeks ago in the "British Journal of Photography," gives some idea of the necessary conditions. The plates used were bathed in an "orthochrome T" solution, and so made extremely sensitive, especially to yellow light. The lens had an aperture of $f/3.0$ (that is, five or six times as large an aperture as an ordinary "rapid" lens), and the exposure was one-tenth of a second. The subjects were figures on the stage, lit in the ordinary methods during public performances. The development was done at 75° Fahr., and the negatives were very thin. As vigorous a transparency as possible was made in the camera, using a slow plate, and the process was repeated on the transparency to get another negative. By then using a printing paper that gives great contrast, the final print was obtained. That is, with such a rapid plate, fast lens, powerful light, and forced development, the one-tenth of a second gave such under-exposure that it required three consecutive struggles after vigour to get a suitable print.

Critical Focussing.—The focussing screens generally supplied with the best cameras are quite serviceable for the more ordinary purposes, including the photography of architectural subjects, but fail altogether when really critical definition is required. They fail because they are not flat, and also because the grain is not, as a rule, fine enough. A home-made screen will be found better, and can be prepared without the exercise of much skill, by getting two pieces of polished patent plate glass of suitable thickness and the required size, and grinding one side of each together until they present, when washed and wiped, an evenly greyed surface. The grinding is done by putting one piece of glass down on a flat board with small brads to prevent it slipping about, but not projecting so high as the upper face of the glass, and working the other glass with a circular motion on it, with fine emery and water between. The emery should be the finest that will cut, obtained by elutriation. The finer the grain of the screen the less bright is the image that falls on it, but the finer the detail, therefore such a screen as described might not be so good for portraiture and views as one with a coarser grain.

But for really critical focussing the surface of the screen must be polished so that the image may not be broken up at all. It is often stated that in such a case a high-power eye-piece must be used, that the accommodation of the eye may not introduce uncertainty. This is an error, for no practical eye-piece could prevent a normal eye from accommodating or focussing itself so as to clearly see the image as it was moved over a considerable distance. There must be marks on the screen surface, and these marks must be seen in sharp focus at the same time as the image; then the marks and the image will be in the same plane irrespective of the power of the eye-piece and the accommodating power of the eye. A common suggestion for getting a clear spot on a ground glass screen, is to cement a microscope cover glass to it with Canada balsam. If this is done a few lead pencil marks should be made first to focus the eye-piece on. I have tried this method a few times, but never succeeded. Of course, the glass and balsam that the light passes through when focussing, but not when exposing the plate, will cause the image plane to be different in the two cases, and whether or not this is the reason, the fact remains that I have not found this method reliable. If a clear or nearly clear spot is wanted on a ground glass screen, the method that is the most successful with me is to rub the part with grease until the desired effect is produced. I have tried a great many oils and fats for this purpose, and find that the simple cerate of the Pharmacopœia is the best.

If the whole screen is to be polished, then a selected piece of patent plate is employed without grinding it, and it remains to get the lines on its surface. It will be found advantageous if these lines are ruled in groups of three, with a greater space between each group and the next than between the members of the group. No method of hand ruling with a diamond has been successful with me, the lines are broken and irregular, but perfect results may be obtained by etching. For this purpose, the selected piece of glass is thoroughly cleaned and dried, then warmed so that when rubbed with a piece of wax, the wax melts and coats the glass. When cold, the film of wax should be complete and thin. To make the lines, which, of course, must go quite through the wax, a needle is not so good as a sharp knife, and this should be drawn along against a straight-edge, exactly as if cutting, but with a light pressure, only just sufficient to go through the wax. For the etching, a piece of thin sheet-lead is bent up at its edges with the fingers, to form a shallow tray. This should be placed out of doors on something level and firm, enough strong sulphuric acid put in it to form a shallow layer, and powdered fluorspar scattered evenly on to it. Hydrofluoric acid is soon evolved, and the glass, with its waxed side downwards is placed over it, resting on the edges of the dish. In a short time, a minute or two, perhaps, the etching will be sufficient. The glass is warmed, the melted wax wiped off, the glass well cleaned, and the lines examined with an eye-piece. The best amount of etching should be determined by experiment, noting how long the glass remains on the lead dish. Those not accustomed to hydrofluoric acid need warning that they should be very careful not to inhale any of it, or to allow the gas to come in contact with their person in any way. But with no more than ordinary care, and working out of doors as described above, there is no reason to fear trouble. The dish, after use, should be washed out with a copious supply of water before bringing it into the house.

Wratten's Panchromatic Plate.—Referring to my remarks on this last month, the makers inform me that it is a bathed plate. This therefore accounts for its especial properties.

The Committee of Bibliography, and of Astronomical Sciences, of the Royal Observatory of Belgium, has undertaken to publish a list of the observatories and astronomers of the whole world. A request for information, in the form of a list of questions, with a model reply relating to the Astronomical Service at the Uccle Observatory, Belgium, has been addressed to all the directors of observatories. In addition the list will include such astronomers (University professors, amateurs, &c.), who are not attached to any observatory, but are nevertheless actively engaged in astronomical research. The information already sent will enable the Committee to draw up not only a list of observatories, with their geographical co-ordinates and the members of the staff, but also a table showing the astronomical activity of the whole world, thanks to the facts given as to the instruments at the disposal of each institution, the pieces of research undertaken, and the papers published. We are asked to appeal to the directors of those observatories who have not received the question-form, or who have not yet forwarded a reply, as well as to unattached astronomers, and trust they will send the information desired, or to repair any omissions, as soon as possible, addressed to the Chairman of the Committee, Prof. P. Stroobant, astronomer at the Royal Observatory of Belgium, Uccle, Belgium.

The New Planet TG.

By A. C. D. Crommelin.

The zone of asteroids has certainly attracted more attention from astronomers since the discovery of Eros in 1898. There was a natural expectation that further sensational orbits might be discovered, and after a lapse of eight years this expectation has been realised. The planet TG is indeed of less practical importance than Eros, which has already proved so useful in measuring the Sun's distance, but its theoretical interest is nearly, if not quite, as high. The new planet is remarkable for its very large mean distance, which is practically identical with that of Jupiter; and as it has a considerable eccentricity, its aphelion lies far outside Jupiter's orbit, so that the family of asteroids, as now known, ranges from distance 1.1 (perihelion of Eros) to distance 6.1 (aphelion of TG). They have in fact burst their bounds in each direction, going far inside the orbit of Mars and far outside that of Jupiter. It is probable that the disturbing action of these two planets has brought Eros and TG into their present orbits. Herr Dziewulski, of Cracow, has recently published some researches on the motion of Eros, in which he takes account of the modification of its orbit produced by the action of the other planets, and finds that about B.C. 7,400 its orbit intersected that of Mars, so that very close approaches of the two planets would be likely to occur. It is, in fact, very probable that the orbit of Eros was deflected into its present position by such an encounter or series of encounters with Mars. Its orbit even now cannot be looked on as perfectly stable, for about A.D. 8,800 it will again intersect that of Mars, and further notable changes are likely to occur, whose exact character it is at present impossible to determine.

It would at first sight appear that TG was in still greater danger of destructive changes in its orbit than Eros, for its troublesome neighbour is not the small and feeble Mars, but the giant planet Jupiter, notorious for the mighty disturbances which he produces in the orbits of heavenly bodies so unfortunate as to pass near him. However, Professor C. V. L. Charlier (in *Astr. Nachrichten*, No. 4,094) indicates a possible way of escape for TG from such destructive changes, which will at the same time afford a most interesting illustration of a principle which had already been recognised as theoretically possible, although no actual case was known. The "Problem of Three Bodies" or the attempt to arrive at expressions which will give their mutual positions at any time we may desire, is probably insoluble in the general case, though the results of lunar and planetary theory have been arrived at thanks to the circumstance that in these cases one of the attracting bodies is greatly superior to the others in its action, and a solution by successive approximation is thus rendered possible. There are, however, a few simple cases where a rigorous solution of the problem has been arrived at. One is when the three bodies are in a straight line and also moving in that line. In this case elementary methods suffice for a solution (at least so long as no collision takes place; if such happens a knowledge of the elasticity of the bodies is required, before we can predict their subsequent behaviour). A more interesting case is the one which Dr. Charlier considers may very probably be exemplified by the Sun, Jupiter and TG. Lagrange showed that if three bodies are placed at the angles of an equilateral triangle and projected with appropriate speeds in the proper directions, they will continue to form an equilateral triangle unless disturbed by some extraneous force such as a fourth body, a resisting medium, etc. Dr. Charlier himself continued the investigation in "Publications of the Lund Observatory," No. 18, and showed that the system might still be stable, even if the triangle were not accurately equilateral to start with; we should in this case get oscillatory motion, never deviating very widely from the symmetrical form. There are two reasons for thinking that the three bodies named above form a system of this kind: (1) The period found for TG by Dr. Berberich (viz., 12.02 years) is almost exactly the same as that of Jupiter (11.86 years). As the planet has only been under observation for three months it is quite possible that Dr. Berberich's period is in error by this trifling amount (about two months), and that the periods are really exactly equal. We shall probably have to wait till next year before this point is certainly known. (2) The angle subtended at the Sun between Jupiter and TG does not differ greatly from 60°. It was in fact 55° 31' on February 22 last, which is quite within the possible range of oscillation about a mean value of 60°.

Assuming that the period of TG is really 11.86 years, Dr. Charlier finds that its motion can be approximately pictured as follows: (1) Consider a point travelling in an ellipse about the Sun with the period 11.86 years, but with the perihelion point advancing so that the period from the perihelion passage to the next is 11.90 years. (2) Consider TG as moving in a small ellipse round this point in a period of 148 years. The size of the ellipse will be deducible when the elements of TG are better determined, but it may be large enough to produce a very noticeable shift in the position of TG. Dr. Charlier has considered the case of a small planet whose orbit plane coincides with that of Jupiter. The plane of TG deviates very notably from this, and there will, I suppose, be similar perturbations in latitude, viz., one with a period of about twelve years, which is practically the principal term in latitude, and another with a much longer period. Of course TG will be liable in addition to perturbations by the other planets, of which Saturn will play by far the greater *rôle*. These, however, will be of an oscillatory character, and will probably not tend to derange permanently the balance of the system. It is to be hoped that Dr. Charlier's expectations may be verified, and that TG may indeed prove to exemplify a type of motion so wonderfully anticipated by the great Lagrange more than a century ago. To strengthen his case he states as a conjecture that Jupiter would probably compel a planet that had a period nearly the same as his to take up this exact period, since otherwise its motion would seem to be unstable. He makes the suggestion that the regions 60° distant from Jupiter on each side should be diligently swept for other bodies of the same type, and even extends the suggestion to the case of Saturn, though the prospects here are not very encouraging.

TG must be a fairly large asteroid; judging from its brightness its diameter can scarcely fall below 100 miles, which far exceeds the estimates for most of the recent discoveries. Professor Barnard deduced that Ceres headed the list with 480 miles, Vesta, although brighter, being only 240 miles in diameter. Dr. Berberich's elements follow; it will not be difficult with their aid to insert the orbit in a diagram of the Solar System.

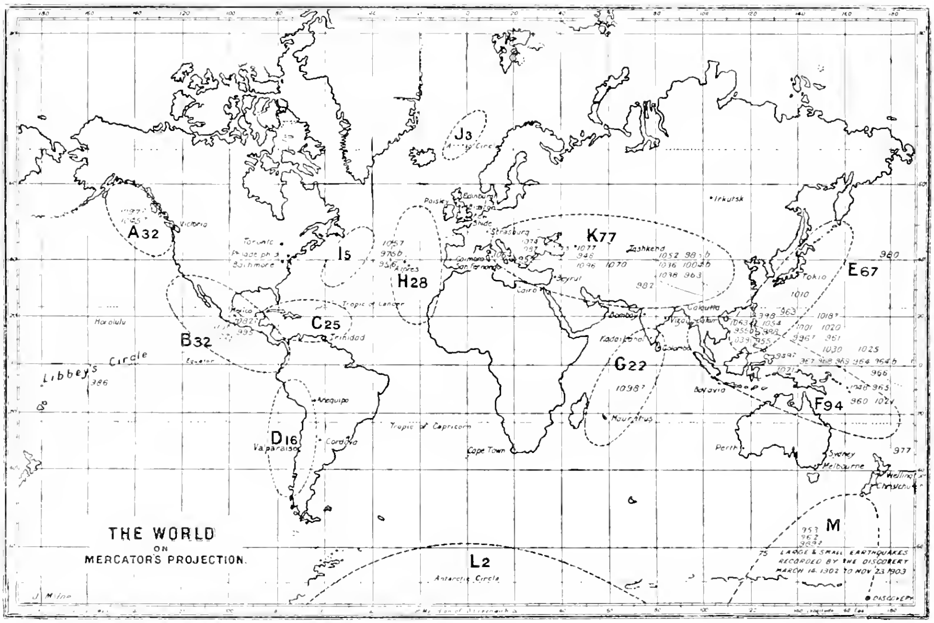
Epoch 1906, Feb. 22, Berlin, M.T. [illegible]		Period [illegible]	
Mean Longitude	48° 57'	Mean distance from Sun	[illegible]
Longitude of Perihelion	[illegible]	Least	[illegible]
" " Asc. Node	315 34	Greatest	[illegible]
Inclination to Ecliptic	10 21		
Eccentricity	0·1670		

Earthquake Areas.

As students of seismology are well aware, the earth's surface contains many large areas where, owing to the distribution of pressure of the strata and the comparative instability of equilibrium among the strata, there is a continual liability to those movements of the earth which are called earthquakes. These areas have been mapped out by Professor John Milne and other observers, and a chart is annually presented to the British Association showing the number of earthquakes that have originated in these areas, and the records of which have been sent to Professor John Milne's observatory at crest of the range to what we may figuratively call its foundations is much greater, and in speculating on the causes of earthquakes we may regard the upper strata on this great pile of stratified rocks as tending to slip over one another. We may further regard the tendency as accentuated by the fact that the lowermost strata, being under very great pressure, are approaching that condition when they tend to lose their solidity and become viscous. Laboratory experiments have shown that given sufficiently high pressure iron can be made to flow. We may presume that the lower rocks will flow also. Therefore, a great mountain range situated next to an ocean is not in stable equilibrium, and a movement sometimes of earth-shaking magnitude may be precipitated by very many apparently slight causes.

British Association, 75th Report, York, 1905. *The Large Earthquakes of 1905.*

Origins for 1905 are indicated by their B.A. Shide Register number. Earthquake districts are indicated A, B, C, &c., and the number of earthquakes which since 1900 have originated from these is expressed in large numerals. Observing stations are named.



Shide, Isle of Wight. In view of the tragic interest of the recent earthquake at Valparaiso, we reproduce this year's chart. Its details and its figures largely explain themselves, and it is only necessary to add in further explanation of them that the major earthquakes, such as arouse disturbances large enough to be recorded on the instruments in the larger number of the world's observatories, are recorded in large numerals, such as A32. The letters A, B, &c., refer merely to the earthquake areas, Andean, Cordillerean, Himalayan, Antillean, &c. It will be noted, as any intelligent observer would have suspected, that the larger number of earthquake areas are situated where there is a great range of mountains, and preferably where the mountain range is in proximity to a sea-board, so that the mountainous range slopes beyond the coast to the ocean floor. In such a case the actual perpendicular distance from the

Among these causes tidal influences and synchronous solar disturbances have been suggested, but the most interesting suggestion made during the last few years has been one which relates to the figure of the earth, and to the movement of the earth's axis. The movements of the earth's axis are not uniform, and if a curve be plotted showing the path described by the earth's pole in its periodic cycle, it will be found that the path traced is not regular, but contains irregular and sudden alterations of the curve. Now if the earth were a spherical body all parts of the surafce which were in the same state of strain, it is conceivable that movements of this nature would not affect the stability of its crust. But it is evident that the crust of the earth is not of uniform stability, and it has lately been suggested by Sir G. H. Darwin and Mr. Jeans, of Cambridge, that the earth is not sphere-shaped, but shows traces in its form of a period when it was pear-shaped. The waist of the pear would be its weakest region or line, and along this line any strain resulting from sudden disturbances of the earth's axis would be felt more severely than anywhere else. If the regions along this line of weakness had a predisposition or susceptibility to earthquake movement, then in a time of stress we should expect earthquakes to be manifest chiefly along this line. That, according to Professor Milne, is what we found last year. A glance at the map shows that of the 57 widespread earthquakes of last year, the great majority were confined to a circle passing from Central America through the Azores, the Alpine, Balkan, and Himalayan ranges into the East Indian Archipelago. The quiescence of districts which do not lie on this band was very marked during 1905, though it has now been sensationally interrupted by the Valparaiso earthquake. There was a destructive earthquake in Calabria on September 8, 1905, but Professor Milne is not sure whether it was in any way connected with the relief of volcanic stress which began as early as May, 1905, and culminated in the violent eruptions at Vesuvius in April, 1906. The largest earthquakes, eclipsing this, or the Indian one of April 4, 1905, or even that which on April 18 of this year devastated Central California, were two which occurred in Central Asia in July of last year. No accounts of destruction, however, reached England, so that the districts where they occurred must have been sparsely populated. One of them was felt at Tomsk, in Siberia.

Other observations in Professor Milne's report disclosed the interesting suggestion that on the west side of the Pacific earthquakes are more frequent in summer, while on the eastern side they are more frequent in winter. It is suggested that an explanation can be found in the seasonal alternation in the flow of ocean currents, the oscillation of sea level, and the changes in barometric gradients—phenomena which are all connected with one another. The most curious observations in the report are, however, as follows :—" It has been found that under certain but frequently recurring conditions the two opposite sides of a valley move in opposite directions at the same time. On bright, fine days the inclinations of the sides of a valley decrease. At night they increase. A valley may, therefore, be supposed to open and close. These conclusions, which do not necessarily apply to all valleys, are based on observations taken in two very different localities. The first were made in Tokyo, Japan, by means of horizontal pendulums giving continuous photographic records, installed on the two sides of a valley cut in alluvium. The phenomena may be due to the general warping of a district under the influence of solar radiation, or to the differential effects of loading and unloading of portions of the same. During the day the sides of a valley covered with vegetation lose load by evaporation and transpiration, and, therefore, underground drainage, tending to carry a water load to the bottom of a valley, is reduced. At night, with the cessation of these processes, the load at the bottom of a valley is increased. At that time streams and certain wells carry their greatest quantity of water. It is, therefore, at night that a valley may be expected to sag downwards, a suggestion that finds support in the observation that during wet weather, when we see streams in flood, the sides of the bounding valley approach each other in a marked manner. The conclusion is that as the world turns before the sun its surface is measurably smoothed, while at night the frecklings on its face are measurably increased."—E. S. G.

A Great Catalogue of Double Stars.

It is only within the last two or three centuries that it has been recognised that there are such things as "Double Stars"; that there are systems where two or more suns share the supreme control; unlike the case of our own system wherein our sun, lord paramount in its own family, exercises a single and undivided sway. The first star to be noted as double was Zeta Ursæ Majoris, the "Star of the Girdle," discovered to be double by the astronomer Riccioli about the middle of the seventeenth century. It is a curious coincidence that this same star had also the distinction of being the first to be photographed as double, and again its components were the first to show themselves to be spectroscopic doubles.

The first great worker on double stars was Sir William Herschel, a century and a half later than Riccioli. He observed and catalogued them, not for his interest in them as such, but because he hoped to employ them in finding the parallaxes of the fixed stars. Before his day instruments were neither sufficiently powerful nor sufficiently refined to render possible the delicate measurements needed in such an inquiry. But Herschel was himself a great instrument maker, and was, therefore, himself able to overcome much of the instrumental difficulty of the problem; the outstanding difficulties he proposed to avoid by contenting himself with determining, not the absolute parallax of a star, but its relative parallax as compared with one which was at an indefinitely greater distance from us. His plan, therefore, rested upon the assumption that where we have two stars apparently close together in the sky, the fainter star is really immensely more distant than the brighter, and is only seen near it because the two chance to be nearly in the same line of sight. His plan failed because the faint comparison stars, which he chose, proved in so many cases not to be far distant from the stars whose parallaxes he sought, but to be so close that they were strongly bound together by gravity and moved together through the universe. The result of his inquiry, however, was that he produced the first catalogue of double stars. Herschel's eminent successor in this class of observation was the Russian astronomer, Wilhelm Struve. He began his astronomical career in 1813, and in 1837 he published at St. Petersburg his great work, generally known as the "Mensuræ Micrometricæ," containing the positions of 2,640 double stars.

About a quarter of a century ago Mr. Thomas Lewis, the Superintendent of the Time Department of the Royal Observatory, Greenwich, began in his leisure time a study of this great catalogue of Struve's, collating all the measures of the objects contained in it which he could gather from every available source. The result of this study showed that many of Struve's pairs had been neglected by observers, and about twelve years ago, at Mr. Lewis's request, the Astronomer-Royal granted him facilities for having these objects measured by the great Grubb refractor of 28 inches aperture, belonging to the Royal Observatory, Greenwich. This enabled Mr. Lewis to complete his study of Struve's great catalogue, and on his work being submitted to the Royal Astronomical Society, the Council decided to publish it as one of their Memoirs. In this magnificent volume, 715 pages quarto, Mr. Lewis has brought together the original observations made by Struve, of each double star, the observations made on the same by various observers throughout the world up to the present time, and those made by himself and his co-workers at Greenwich. From these he has deduced the orbits in which the pairs move about each other, wherever the material available is sufficient for that purpose, adding, wherever possible, particulars as to their masses, sizes, colours, and spectra.

There is no nationality in science, and yet there is a legitimate source for gratification that so magnificent a Memoir has been brought out by an English astronomer; that the observations of the great English Observatory have contributed so much to its completeness; and that it is published by the great English astronomical society. For, as has already been mentioned, it was an Englishman who founded double star astronomy, and some of the most distinguished workers in the field in its early days were also Englishmen. Towards the end of the nineteenth century, however, this important department was falling into neglect amongst English observers; the present President of the Royal Astronomical Society, Mr. W. H. Maw, being one of the very few who were keeping up the traditions of the Herschels, father and son, of the Rev. W. Dawes, and other great names of the earlier part of the century. The appearance of this Memoir is a proof that the subject has not lost its interest to English astronomers of to-day, and that it is being followed up with an energy and a skill in no way inferior to those of the very best workers of earlier days.

And the Memoir will tend to develop further activity in this field, and to render that activity much more efficient. It will be a great help to the double star observer thus to be at once put in possession of the observational history of any given star, without the necessity for a long and arduous search through records; whilst he can here readily learn what stars have been fully observed and what have been neglected, and when it is needful that this or that binary should be specially watched. The Memoir is not only a record of past work; it will be an important basis for work in the future.

But Mr. Lewis's work has a significance quite apart from the presentation of details respecting the relative motions of certain close stars, and it affords a remarkable example of the way in which the various problems of astronomy are intermingled, the one with the other. At first sight it would appear most unlikely that the watch upon one member of a pair of stars as it slowly gravitates round the other, should afford any clue as to the general form of the stellar universe; yet, as Mr. Lewis has shown in his Introduction, this altogether unexpected information does come out from the present Memoir. This important result partly follows from the far-seeing and comprehensive character of Struve's original work, and partly from the simple but ingenious treatment to which Mr. Lewis has subjected the material at his disposal.

During the two years, February 11, 1825, to February 11, 1827, Struve examined 120,000 stars from the first to the eleventh magnitude, and found 3,112 double stars, whose distance apart did not exceed 32″. Several of these pairs were rejected from the final catalogue of 1837, the "Mensuræ Micrometricæ" and a few fresh ones were added, so that the 1837 catalogue contains 2,640 pairs. Now in the seventy years which separates us from the date of the "Mensuræ Micrometricæ," many of these objects show no clear evidence of relative motion; others as unmistakably are moving the one with respect to the other. Mr. Lewis, therefore, divides the items of the catalogue into two classes—pairs in which the members are relatively fixed, and pairs of which the members show a motion relative the one to the other.

Now if we examine the distribution of the stars of the catalogue, certain facts become apparent. First of all an examination of double stars in general—no distinction being made between fixed pairs and pairs with relative motion—shows that their distribution follows very closely the distribution of stars in general. But quite a different state of things prevails if we inquire as to the proportion which the fixed pairs bear to the relatively moving pairs in different parts of the sky. The natural expectation would be that the two classes would show the same general law of distribution, and hence that the ratio $\frac{F}{M}$ would be much the same from whatever region of the sky it was derived. As a matter of fact its value is about three times as great in one region of the heavens as it is in the opposite.

What can be the explanation of this curious and strongly marked relation? Mr. Lewis explains it as follows:—

> "There is a very simple cause which might alter the proportion between fixed and moving pairs in different parts of the sky.
>
> "Given a keen observer with an instrument of a certain power, and let him tabulate the stars which appear double or multiple in a systematic search, and suppose, for example, that he can find such a triple as Σ 2367, where
>
> A and B are separated 0″.4 and form a rapid binary,
>
> A and C are separated 14″.1 and are relatively fixed.
>
> "Now reduce the power of his instrument to one-third and he can no longer see B, since 1″.2 is the smallest separation he can perceive—he might elongate 0″.8 The pair AC becomes a double star with no relative motion. The same effect is obtained by retaining his original instrument and removing the triple to three times its former distance. The separating power of his telescope is 0″.4, but B's distance from A is now 0″.13, and C's is 4″.7, so that B is still invisible, and C a fairly near companion without relative motion.
>
> "Put in a different manner, my suggestion is:—
>
> "There is no apparent reason why distant stars should not have close companions endowed with orbital motion as frequently as those nearer to us, nor is there any known reason why double stars should not be evenly distributed in space. If we find this distribution is not uniform it may be that in certain regions the stars are, as a whole, more distant from us than in others. Granting this, the proportion of fixed pairs to pairs showing relative motion should be a function of the distance of the stars from us."

It will be remembered that some three years ago Dr. Alfred Russel Wallace brought out a most interesting book the purport of which was to show that the entire trend of modern astronomy proved that the solar system was in the centre of the entire visible universe. It is one of life's little ironies that at that very time Mr. Lewis's Memoir was ready for presentation to the Royal Astronomical Society, with his demonstration that the statistics of double stars appear to show that the stars around us form a universe very much the shape of an egg, and that we are not situated in the centre, but are upon one of the minor axes, and on that axis are three times as far from one extremity as we are from the other. Mr. Lewis estimates the longest diameter of the egg as roughly equivalent to six hundred light-years, the smallest diameter to three hundred light-years. The average proper motion for pairs showing relative motion is three times that of pairs showing no relative motion.

This important result is far from being the only one which Mr. Lewis has deduced from his inquiry. There was a time when the observation of double stars would have been considered suitable enough for amateur astronomers, but quite beneath the dignity of a great Government Observatory; indeed, it is doubtful whether the earlier Astronomers-Royal would have consented to give the work a place upon the Greenwich programme, seeing that the original purpose of the Observatory was the determination of the exact positions of the stars and the following of the movements of the sun, moon, and planets. Yet even from the standpoint of the severest interpretation of the original warrant for the Royal Observatory, double star work in Mr. Lewis's hands has justified itself, since in not a few cases it has thrown light upon the observation of stars in the transit circle, interpreting and clearing away apparent discordances. On the other hand, in the case of some binaries, the transit circle observations have enabled a period to be carried back a considerable time before the star was recognised as double, so that the two distinct methods of observation have supplemented each other to an important extent.

Nor is this all. In several instances it has been possible for Mr. Lewis to combine the discussion of the meridian observations of the brighter component with the relative motion of the fainter companion as deduced from the micrometer measures, so as to gain an idea of the relative masses of the two stars. The eighteen cases with which he has been able to deal give some very remarkable results. In twelve out of the eighteen cases the fainter star has the greater mass; in three cases the masses are about equal, although the stars differ considerably in brightness; in three cases the fainter star has the smaller mass, but the predominance of the chief star in brightness is enormously out of proportion to its superiority in mass. "As a rule the apparent satellite is, in fact, the primary of the system." The table which Mr. Lewis gives of these eighteen stars is a most suggestive one, for it indicates that the mass of the fainter star is much more closely related to its colour, that is to say, to its spectrum, than it is to its stellar magnitude. Given a star of the solar type of spectrum with a companion purple or bluish in colour (and, therefore, naturally assumed to be of the Sirian type), and the latter is, generally speaking, of the greater mass, though much inferior to the solar star in brightness.

Of course, the number of stars as yet available for such treatment is far too small for any broad general conclusions to be based upon them, but the importance of Mr. Lewis's table from a theoretical point of view can hardly be exaggerated. The natural way of looking at stellar evolution is to assume that the star of greater mass will cool the more slowly, and consequently that, of the members of a pair, the heavier star must be the hotter; we also naturally assume that it must be the more luminous as well. Yet the results which Mr. Lewis has put before us, so far as they go, emphatically negative this reasoning. Then, again, as between stars of the solar and of the Sirian types, it has been usually assumed that the latter are intrinsically much the brighter of the two, but in the view of the facts here presented this assumption will in future have to be revised.

One of the early workers upon double stars, Sir James South, on the publication of Struve's great work in 1837, is reported to have exclaimed, "There is nothing left for me to do!" South had not learnt that good work does not preclude further work, but forms the best possible basis for it; and we see from Mr. Lewis's Memoir at once how great and how important has been the work which others have built upon the foundation which W. Struve laid so broadly and so well.

Liquid Air.

The Knudsen System.

Since liquid air was made some years ago, at great expense, in the laboratory, its possible applications in industry as well as in science have become increasingly evident, and at the same time new and improved methods of manufacture have steadily reduced its cost. The latest and cheapest of these methods of manufacture, which reduces the price of liquid air to a hundredth, perhaps a thousandth, part of that at which it stood a few years ago, is called the Knudsen system, an installation of which has just been opened in Church Road, Battersea, by Major B. Baden-Powell. Early methods of liquid air manufacture depended on what is known as the cascade system; that is to say, that continually decreasing temperatures were obtained by causing successive volatile liquids to boil at reduced pressures. Thus ethylene, which boils below the freezing point of water, will boil at a lower temperature when the pressure of the atmosphere is taken from its surface, and will help to produce a degree of cold sufficient to liquefy carbonic acid gas, while the normally low temperature of liquid carbonic acid can similarly be reduced by again reducing the atmospheric pressure. Thus, as in a cascade, the temperature grows lower and lower by successive falls. The alternative method, of which Knudsen's is a type, depends on the principle of the adiabatic expansion of gases. When a gas is compressed heat is produced; when a compressed gas is allowed to expand suddenly, cold is produced.

In the Knudsen system atmospheric air is first of all purified and freed from dust, and is then compressed in a three-stage air compressor. In the first low pressure cylinder it is compressed to 90 lbs. pressure, in the second intermediate to 550, and in the third high pressure cylinder the pressure is 2,500 to the square inch. The air is cooled between the stages of compression to the temperature of the cooling water. After the air has been freed from dust and compressed to 2,500 lbs. to the square inch, it then enters a moisture separator, which removes the moisture from the air, as well as the oil and other impurities which might have vaporised and passed over in the process of compression.

The air, still at a pressure of 2,500 lbs. to the square inch, passes next through a number of copper coils. Surrounding these coils cold air from the liquefier passes in the opposite direction and lowers their temperature sufficiently to freeze the traces of moisture on the inside of the coils, leaving absolutely pure dry air to be liquefied.

The purified dry high pressure air then enters the outer coils (seven in number). It passes through the three outer ones first. At the bottom of the apparatus there is a receptacle connecting the three coils together with the four others; this receptacle serves the purpose of separating the carbonic acid gas. After the air has left the four coils, it enters at the top of the central part of the liquefier. Here the air compressed passes through a number of very fine copper tubes to the bottom, and to a number of high pressure expansion valves. By these the air is reduced from 2,500 lbs. per square inch to 125 lbs. to the square inch, with a consequent great reduction of temperature. Thence returning over the small tubes it cools the high pressure air in them to such an extent that the air liquefies partly in the tubes and partly in the expansion valves.

The air which does not liquefy on expansion then returns over the small copper tubes, which are enclosed in a large copper vessel and connected with a pipe at the top leading to the turbine, where the air under 125 lbs. pressure is again expanded as nearly as possible to atmospheric pressure. It is thus doing work in the turbine, and thereby cooling itself to a temperature many degrees greater than before entering the turbine under pressure.

This cooling reagent in the form of exhaust air from the turbine re-enters the liquefiers at the top of the apparatus, circulating in the opposite direction to the high pressure air within the coils. This highly-compressed air passes over the four copper coils, in a downward direction, and then returns in the upward direction over the three first large coils of the liquefier. Thence it circulates as previously explained over one of the two moisture separators, and then to the conduct pipe to the low pressure cylinder of the air compressor, together with the atmospheric air drawn from the dust separator. The power which is saved by expanding air in the turbine is utilised for operating a small air compressor, and the air is utilised for cooling the high pressure air.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Prominences Observed during 1905—January 1 to June 30.

THE Director of the Kodaikanal Solar Physics Observatory in South India has recently issued a second list of prominences, from observations made during the first half of 1905. The present record is rendered more complete by the fact that the prominences photographed with the spectroheliograph have been indexed, in addition to those recorded visually. The two conditions, of course, represent conditions of matter of two distinctly separate elements, the prominences recorded visually in the C(Hα) line being due to hydrogen, while those recorded photographically in the H line are due to calcium. Very interesting and important discussions arise from the minute comparative examination of these two sets of observations, and it is stated that from fifteen months' observations it appears that near the time of sun-spot maximum the prominences, as seen in hydrogen, agree, as a rule, very closely in form with those photographed in calcium light. There are a few prominences seen in the hydrogen radiation which are not found on the photographs taken with calcium light, and there are a larger number photographed in calcium which have not been seen in hydrogen. It is expressly stated, however, that it cannot be assumed without much further examination that all those photographed but not seen were actually absent from the hydrogen radiation. In many cases it is probable that the bright background of sky covered with thin clouds prevented their detection visually. Again, while, in general, the calcium and hydrogen prominences agree closely, there are frequently very marked differences. The chief of these is that whereas the visually-observed hydrogen prominences consist very often of a network of fine jets or filaments, the calcium prominences show a more continuous structure.

Of considerable importance from a physical standpoint is the statement that spectroheliograms of the disc of the sun occasionally show prominences extending to a considerable distance *inside* the limb, either (1) as an area of *dark flocculi* or (2) as an area *less dark* than the surrounding area, thus indicating greater absorption.

The tables contain details of more than 2,000 prominences determined during the half-year, giving the time of observation (Madras Mean Time), latitude, position on limb, and height in seconds of arc, an appendix of remarks being added for notes of special phenomena.—*Kodaikanal Observatory Bulletin*, No. 5.

Sun-Spots of 1906.

In the August number of the *Observatory* Mr. E. W. Maunder starts an interesting experiment in the publication of advance astronomical data. It is well known that the Greenwich serial spot numbers are standard for many solar workers, but hitherto these have not been available until the complete measures and reductions had been made, generally some six months after the end of the current year. By permission of the Astronomer Royal Mr. Maunder has made a preliminary examination of the solar photographs as soon as the necessary supplemental negatives have arrived from India, and numbered the spot groups at once. In an accompanying table he gives such serial numbers for the spots from December 24, 1905, to March 27, 1906. Additional information includes the duration of the spot, date of passing central meridian, longitude and latitude, the two latter being estimations only. In making use of this information it is to be understood that, while the numbering of the groups is definitive, the other particulars relating to the groups have only been derived from a preliminary examination of the photographs, and may subsequently be modified when measured correctly. This information, however, will be widely welcomed by workers desiring to use these statistics in connection with other work.

New Iron Arc Wave Length Standards.

In consequence of a decision by the Solar Union at Oxford in September, 1905, recommending the establishment of a new system of reference standards of wave length, MM. Fabry and Buisson have undertaken the task, and their results for the region λ3600-6500 have recently been published. The source of light was the iron arc, produced between poles 8 mm. diameter by a current of 3·6 ampères at a pressure of 120 volts. Each line selected for standardisation has been compared directly with the green ray of mercury given by a Cooper-Hewitt mercury lamp, this green line having itself been rigorously compared with the standard lines of cadmium. All these new determinations have been made by photography. To eliminate any errors due to expansion of the interferential apparatus the mercury comparison was photographed both before and after the exposure to the iron arc. The number of rays measured and tabulated to three decimals (thousandths of a tenth metre) is 84, each having been determined several times on different plates. In the region near λ5800, where there is rather a large gap without iron lines, four lines of nickel have been included. The wave lengths given are based on those of Michelson and Benoit for the green and red lines of cadmium, and like them, are the values in air at 15° C. and 760 mm. pressure.—*Comptes Rendus* 143, p. 165.

New Form of Spectroheliograph.

Experiments with various forms of spectroheliograph have led Messrs. G. Millochau and M. Stefanik to design a new apparatus, in which the chief feature is the attempt at eliminating friction and consequent distortion. A two-slit spectrograph, of any form, is mounted so as to move round a horizontal axis perpendicular to the plane containing the optical axis of the combination. The motion of the apparatus is produced by a Brashear clepsydra, mounted vertically. This is connected with the spectrograph by means of a bar with pointed extremities, which enter into two conical holes, one of which is on the spectrograph in the prolongation of the optical axis of the collimator, while the other is at the end of the piston rod of the clepsydra. The axis of rotation of the spectroheliograph must pass through the point of intersection of the axis of the collimator and that of the telescope of the spectrograph. The distances between this axis and the two slits should be in the ratio of the focal lengths of the collimator and telescope objectives. If a grating is employed (and the recent discovery by Hale of the existence of dark hydrogen flocculi has shown the advantage of the greater dispersion given by a grating spectrum) the second slit may be stationary, and placed in the axis of the telescope; the setting on the spectral line can then be accomplished by a slow rotation of the grating. At its two extremities the secondary slit is widened for the purpose of taking a photograph of a portion of the spectrum of the diffuse light of the sky, thereby providing a simple means of determining the exact radiation with which the monochromatic photograph is to be obtained. A photographic plate may be placed immediately behind the secondary slit, supported by the stationary base of the instrument (Hale's arrangement), or the image may be photographed with a separate camera (Braun's arrangement). In this latter case the image may be enlarged or otherwise at will. This form of spectroheliograph may be arranged to receive light from a siderostat or a coelostat, or it may be attached directly to an equatorial.—*Astrophysical Journal*, July, 1906.

Observations of the Zodiacal Light.

Mr. Maxwell Hall has been making minute observations of the zodiacal light for many years past at Kempshot, in Jamaica, and, in a recent communication to the *Monthly Weather Review*, he brings together most of the observations and discusses them. His first series of tables show the estimated breadth of the phenomenon at varying angular distances from the sun. In the hope of obtaining additional information he employed a spectroscope on the subject, but he says that no bright or dark lines could be detected; its spectrum—what there was of it—was continuous, and coincided with the brightest part of the solar spectrum, being for all practical purposes apparently identical with the spectrum of twilight. Further work with a specially designed spectroscope only confirmed the view that the zodiacal light was reflected light from the sun. Close examination of many measurements of the breadth indicated that instead of the light being bounded by straight lines from the horizon upward these boundaries were curved very perceptibly.

The author next groups the observed latitudes of the various parts of the glow with respect to their longitudes or distances from the first point of Aries. In the resulting table there is certainly a suggestive symmetry, and further inquiry shows that the zodiacal light does not follow the ecliptic as has long been supposed from casual observation, but that it closely follows the invariable plane of the solar system. This plane not only has a mathematical conception, but it may also be regarded as the original plane of the solar system, throughout which was scattered all the matter subsequently condensed into the sun and planets. Employing the more recently determined values of the masses of the planets, the value found for this invariable plane is—

Inclination to ecliptic ...	1° 35′ 2″	(1900·0).
Longitude of ascending node	106° 52′ 37″	

Tabulating now the latitudes of the zodiacal light with respect to this plane, they are seen to agree very closely except at longitude 238°; it is thought that the discordance here may be due to the brightness of the planet Venus interfering with the observations.

The observations made by Mr. Maunder in Egypt about the end of 1897 are discussed, showing the zodiacal light to be parallel to the invariable plane, but some 1½° to the north. This is a tendency common to observations at all northern stations, and a series of authentic observations at southern stations would probably prove most useful. In conclusion, the author expresses the opinion that the invariable plane still contains such a large quantity of meteoritic matter as to reflect back the light of the sun in the form usually seen; also that the "*gegenschein*" or counterglow, may be due to the "*full moon phase*" of these particles of matter, and that all the observed irregularities of light are due to the irregularities in the distribution of the matter.

Meteorology at High Altitudes.

Most of the information concerning the upper air has been obtained by means of automatic meteorological recorders attached to kites or balloons. On November 29, 1905, a kite sent up from the Prussian Aeronautic Observatory at Lindeberg attained the record altitude of 6,430 metres. The self-registering instruments carried by the kite showed that at that height the temperature was −25°, the temperature at ground level being +5°; the wind had a velocity of 25 metres per second, that at the surface of the earth being only 8 metres per second. Six kites were employed, having a total surface of 27 metres, the length of line paid out being 14,500 metres. —*Ciel et Terre*.

Astronomical Clocks.

The astronomical clock is so important an instrument of the observatory equipment that any radical improvement or alteration appears to deserve special notice. The chief drawback to the employment of a first-rate clock has naturally been the expense, but much of this difficulty has been eliminated by the new offer of Messrs. E. Dent and Co.—a guaranteed inexpensive observatory clock at practically one-quarter the cost of the type of instrument which has hitherto been only available to the larger institutions. The new clocks can be obtained with either 12-inch or 10-inch dials, are fitted with dead-beat escapement and wood-rod second pendulum, and may be rated to either solar or sidereal time. If desired, electric contacts can be fitted at a small additional cost for transit work. By the kindness of Messrs. Dent we have been able to examine the rate record of one of these clocks, checked every morning by the standard Greenwich signal, and the variations shown indicate a very satisfactory compensation.

BOTANICAL.

By G. Massee.

The Wild Flora of Kew Gardens.

Quite recently a special number of the *Kew Bulletin* has been devoted to the wild Fauna and Flora of Kew Gardens. As would be expected, intensive cultivation has altered the general features of the ground, and habitats at one time suitable for wild plants have now disappeared. Flowering plants have suffered most in this respect, and out of the 422 species listed, many have now disappeared for ever. Among interesting mosses are *Amblystegium Kochii*, known only from one or two counties in England, *Fissidens crassipes* and *Hypnum elodes*. Liverworts are very poorly represented in the list, although they are known to have been more abundant years ago, but unfortunately no early records nor specimens are forthcoming. Lichens, as would be expected, on account of their impatience of pure air, have practically disappeared, only fifteen species being enumerated, and these are mostly sterile. The paucity of members of the above-mentioned groups is atoned for by the Fungi, which at the present day number 378 genera and quite 2,000 species. The richness of the Mycologic Flora of the Gardens far surpasses in point of numbers, as also in the variety of rare and interesting species, any other record for an equal area. The richness of the fungal flora will be more fully realised when it is remembered that the entire British Fungus Flora consists of 5,000 species, and that of Europe of 8,000 species. In the genus *Russula* 53 species have been noted during the last ten years, out of a total of 01 British species. The large size and brilliant colouring of most kinds belonging to this genus render them very conspicuous objects in the arboretum during late summer and early autumn. Fresh-water algæ are present in considerable numbers, and the list could probably be considerably augmented if special attention was paid to those microscopic forms occurring on damp walls warm water tanks, etc.

Welwitschia mirabilis.

This remarkable plant, one of the wonders of the vegetable kingdom, was discovered by Welwitsch in West Tropical Africa. The plant has a short obconic trunk mostly buried in sand; in old plants the trunk measures three to four feet in diameter at the crown. The two seed leaves or cotyledons are persistent, and in old plants are six to nine feet long; no other leaves are produced. Quite recently Professor Pearson has studied this plant in its native habitat, and added considerably to our knowledge of its habit and structure. The plant grows in desert regions and a portion of the water necessary for its growth is derived from the dense night-fogs prevalent, but the main supply is furnished by the very long root tapping subterranean water. When several plants grow close together natural grafts of a very remarkable appearance are often formed. The plant is diœcious and pollination is partly, if not entirely, due to insects. The maximum age attained by individual plants is probably much greater than a century. *Welwitschia* belongs to the ancient group of Gymnosperms, and microscopic structure indicates affinity with the genera *Gnetum* and *Ephedra*. The details are contained in *Phil. Tran. Roy. Soc.*, 198.

Dry Farming.

Under this heading Mr. Cowan indicates in the *Century Magazine* the methods by which remunerative farming can be followed in regions where the rainfall is insufficient for the successful cultivation of ordinary crops by the usual farming methods. It has been amply demonstrated that wherever the annual average rainfall amounts to twelve inches, as good crops can be raised without irrigation as with it. The Campbell system of dry farming, named after the pioneer "dry farmer" of arid America, consists of a scientific method of soil culture and is based on the movements of water in the soil by capillary attraction. The underlying principles are two in number, and are as follows. "First, keep the surface of the land under cultivation loose and finely pulverised. This forms a soil mulch that permits the rains and melting snows to percolate readily through to the compacted soil beneath, and that at the same time prevents the moisture stored in the ground from being brought to the surface by capillary attraction, to be absorbed by the hot, dry air. The second is to keep the subsoil finely pulverised and firmly compacted, increasing its water-holding capacity and its capillary attraction, and placing it in the best possible physical condition for the germination of seed and the development of plant roots." If the method indicated is thoroughly carried out a rainfall of twelve inches is effectively preserved, and produces better crops than in those places that have an annual rainfall of twenty-four inches, and the farming is conducted on old lines. In opening up a new district the land is first deeply ploughed, behind the plough follows a special implement called a sub-soil packer; the surface is then harrowed and pulverised. A year should elapse before a crop is planted, this amount of time being required for the collecting and storing of water by the compact sub-soil. The surface is harrowed and pulverised after each rainfall, but not at any other time. When the seed is sown the land is still harrowed after each rainfall until the crop is too far advanced to admit of this process without injury. Immediately after the crop is harvested the land is ploughed, followed by the sub-soil packer, and harrowed after every rain until the time for sowing arrives. Although the method evolved from the enterprise of private individuals, the United States Department of Agriculture has now undertaken the work of demonstration in new districts, and affords facilities for those interested in the matter. The development of this method of farming is of primary importance to the United States, where almost exactly one half of the area of the country has insufficient rainfall for the cultivation of crops by the ordinary methods of farming. All the ordinary cereals, forage plants, fruits, etc., can be grown by the method of "dry farming."

European Plants in the Tropics.

It has been recorded by Lock (*Ann. Roy. Bot. Gard. Peradeniya*) that when European plants are introduced into Ceylon, the changes in habit and other respects that they undergo, appear during the first year, and are permanent. There is no gradual accommodation to changed environment as might have been expected.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Absorption of Odours by Milk.

It is well known that milk has the power of absorbing with great rapidity traces of odorous substances with which it may chance to come in contact. Thus milk that has been exposed for some time in the cow-shed or in the shop may acquire a disagreeable flavour, and even the food given to the cows has not infrequently an influence upon their milk. Experiments to determine the speed of the absorption have recently been carried out by MM. Bordas and Toutplain, who selected formaldehyde as the odorous substance, partly because it can never be a normal constituent of milk, and partly because it can be detected when only present in the faintest traces. They found that milk exposed for about one minute to air containing formaldehyde vapour had absorbed an appreciable amount, and that even when the proportion of formaldehyde in the air was only one in 100,000, an unmistakable reaction was obtained after a few minutes' exposure. So rapid is the absorption that a reaction was given by milk that had been placed in a vessel which had contained a dilute solution of formaldehyde and had subsequently been carefully rinsed with water. The rate of absorption of the vapour appears to decrease as the milk becomes older. It is suggested that this property of milk might be utilised in testing air for traces of formaldehyde.

The Preparation of Hydrogen from Calcium Hydride.

It has been shown by M. Moissan that when metallic calcium in a fine state of division is heated in hydrogen it absorbs a molecule of the gas, to form calcium hydride, CaH_2, a compound which is decomposed on contact with water giving off hydrogen, just as acetylene is liberated under similar conditions from calcium carbide. The manufacture of the hydride as a commercial product has thus two stages, viz., the production of the metal calcium by the electrolysis of fused calcium chloride, and the conversion of the metal into hydride by heating it in horizontal retorts through which is passed a current of hydrogen. The commercial substance is in the form of irregular grey or white lumps, which are very hard, and do not dissolve in the ordinary solvents. They are termed *hydroliths* by M. Jaubert, who also calls attention to their value for military ballooning. They contain about 90 per cent. of pure calcium hydride and yield about one cubic metre of hydrogen per kilo. on treatment with water. They have already been used with success for the initial inflation of balloons, and for the introduction of more gas without risk and without bringing the balloon to earth.

Artificial Silk.

A solution of cupric oxide in ammonia readily dissolves paper and other forms of cellulose, and the dissolved substance can then be re-precipitated by the addition of acids or other substances. This forms the basis of several processes for the manufacture of artificial silk including that embodied in two recent French patents, in which the cellulose is re-precipitated by means of an alkali hydroxide in the form of fine threads, which are washed and freed from ammonia by exposure to a current of air and treatment with a dilute acid. It is claimed that the artificial silk threads thus obtained are perfectly transparent, that they have a very brilliant lustre, and that they are stronger than those produced by other processes. The effect of the alkali upon the cellulose appears to be similar to the change produced in cotton in the so-called "mercerising" process.

Volcanic Carbon Dioxide.

The liberation of carbon dioxide from numerous vents is apparently the final manifestation of volcanic activity in the district of Auvergne. All the mineral springs in the neighbourhood are heavily charged with the gas, and one of those at Montpensier, which issues in a large crevice, has long been known as the "poisoned well." Animals that take refuge in the crevice or come to drink the water are rapidly asphyxiated by the gas, which is always accumulating there. The bodies of birds, rabbits, dogs and sheep are frequently found in this crevice, and many children have lost their lives in the same way. Hitherto, this was the only spring of the kind known, but recently it was noticed that the vegetation to the North-East was discoloured by stains, and these were found to be due to the plants being poisoned by carbon dioxide liberated at these points. Acting on the advice of M. Glangeaud the owner of the land subsequently discovered several places where the gas was being emitted from fissures in the rocks. Two springs were also found in crevices several yards in depth, and these crevices were particularly interesting from the fact that they contained Roman pottery, and the skeletons of oxen, sheep, horses, and a man, and at a lower depth the skeletons of a mammoth and a bison (*Bos priscus*). All of these had apparently been asphyxiated by the gas in the same way as the animals of to-day. Some years ago, it was pointed out that thousands of litres of carbon dioxide were being lost daily in Auvergne, and that it would be profitable to collect and liquefy the gas. This, it was shown, could be done very cheaply and the product would be much purer than the ordinary commercial liquid carbon dioxide, which might contain poisonous impurities such as carbonic oxide, whereas the natural gas contained only carbon dioxide and nitrogen. Liquid carbon dioxide has been prepared for some time past in the volcanic districts of Eifel and Westphalia, and now a start has also been made at Montpensier. The actual amount of gas at present liberated is about 500,000 litres per day, but a much larger quantity could be collected by means of suitable borings.

GEOLOGICAL.

By Edward A. Martin, F.G.S.

Destruction of Valparaiso by Earthquake.

The news to hand of an earthquake at Valparaiso and the surrounding parts of Chili continues the extraordinary earthquake and volcanic history of this remarkable year. Full details are not yet to hand, but the country is well known as being liable to such disturbances. The shock reached Professor Milne's instruments in the Isle of Wight soon after midnight of August 16-17, after travelling 6,000 miles, and that authority is reported to have stated that a movement of earth was perceptible for more than five hours, the actual time of the greatest shock being 7.15 p.m. on August 16. The city of Valparaiso was concerned in the great earthquake of November 19, 1822, when the shock was felt simultaneously over a space of 1,200 miles of Chilian coast. At Valparaiso the coast was elevated three feet, a part of the bed of the sea being exposed, the rocks being covered with dead oysters, mussels, and other molluscs. Great fissures showed themselves, this being a phenomenon particularly noticeable in South American earthquakes. Some of the fissures in the granite extended a mile and a half inland from the coast. The whole of the Chilian coast was raised from three to four feet, and sand and mud-cones a few feet high were opened up in numerous places. It will be well to note whether similar phenomena have now been exhibited.

Chalcedony in the Antrim Basalts.

The occurrence and origin of the Carnmoney chalcedony has recently been described by Mr. James Strachan. The chalcedony occurs in large cracks or veins in the lower basalts of Antrim. These are sometimes as much as 12 inches in width, and from this the cavities thin away into a mere hair's-breadth. These veins have apparently been formed during the consolidation of the lava, for the vein-sides are coated in all degrees of thickness from a mere film to one inch, with the mineral *hullite*, which has been described by Professor Cole as "the altered and hydrated glass of the original basaltic ground-mass." Carnmoney Hill, with its steep escarpment sloping sharply towards the Belfast Lough, is a prominent and picturesque feature in the landscape of the country lying to the north of Belfast. The attention of the geologist is attracted both by the peculiar shape and the comparatively isolated position of this hill, which represents the site of an ancient volcano, from whose throat, in Tertiary times, poured forth part of the Upper Basaltic Lava. On the south side of the hill the denuded "neck" or "plug" of this old volcano may be traced, cutting through the Lower Basalt, the Cretaceous, and older strata. The Upper Basalt and part of the Lower have been removed by denudation, leaving the plugged-up vent, which is almost one-quarter of a mile in diameter. The material of the neck is a vesicular lava similar in appearance to that of the doleritic dykes found in various parts of Co. Antrim.

When Sea-Erosion Commenced.

The subject of sea-erosion of our coasts was again dealt with by the British Association at its recent meeting at York, and Mr. Clement Reid, the reader of the paper, is well able to deal with the subject exhaustively. I must confess, however, to a feeling of doubt as to the advisability of attributing the commencement of the erosion of our cliffs to a time so recent as from three to four thousand years ago. I think that such an estimate is liable to misconception, but I admit that may have been near the time when the sea resumed its position at the foot of the cliffs. But the cliffs then showing owed their existence to erosion in earlier times, although in the meantime, according to the interpretation of most modern geologists, the sea had retired, owing to an upheaval of the whole plateau on which the British Isles stand. When the sea again swept down the plain of the North Sea and reached the old cliffs which it had in a former age carved out of the land, then, of course, cliff-erosion again commenced, and this may have been as recent as the time estimated by Mr. Clement Reid. In this way a convenient starting point may be made, so far as modern erosion is concerned.

The Mediterranean Sea as a Lake.

The pigmy hippopotamus from Cyprus, whose skeleton has just recently been set up in the Natural History Museum, may, with the pigmy elephant of Malta, be regarded as the dwarfed representatives of normal races which formerly peopled tracts of land now covered by the Mediterranean Sea. Their existence brings to mind an ancient era when the Mediterranean was a land-locked sea, before the Straits of Gibraltar existed, and when, possibly, the various islands of the sea had a land connection, either with the mainland or an isthmus which connected Italy and Sicily with the African shores. A rise of the sea bottom of about 220 fathoms would cut off the connection with the Atlantic Ocean, and as a considerable portion of the shore-line of the Mediterranean would undoubtedly share in such an uprise, the area of the sea would become diminished, the new shores being a series of flat sandy steppes such as are found around the inland lakes of Central Asia. The loss by evaporation would still be as great as ever, and the Black Sea would be drawn upon to supply some of the loss, and would, in consequence, also suffer in area in the course of time, even if its shores did not share in the uprise. The subsidence which brought about the Straits of Gibraltar was apparently, however, not experienced so far east, or the Black Sea waters might have become connected with the Central Asian lakes. It is extremely probable that this connection did once exist, and subsequently the level of the Caspian has been so altered by the excessive evaporation which takes place upon its surface, that it is now 108 feet below the level of the Black Sea. The sinking down of the stretch of low sandy country which lies between the Sea of Azov and the Caspian to a comparatively slight extent would bring about a connection between their waters, and the Black Sea would pour its waters into the Caspian, and if the movement of subsidence were general, the sea would reach the salt lake of Aral, and much of Turkestan and

Central Asia would be overwhelmed by the sea. So far as the races of mankind are concerned this might prove of immense benefit, and those whose ingenuity has suggested the flooding of the Sahara might turn their attention with greater benefit to this part of the Czar's dominions. So long as the Straits of Gibraltar remained open, a constant current would pour down from the Atlantic, and many of the salt steppes of Asia would be inundated. The subject is an interesting one for speculation, and one may well remember that what has been in past geological times is quite possible of repetition.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Breeding of Humming Birds.

MR. COLLINGWOOD INGRAM, in the August number of the *Avicultural Magazine*, gives a most interesting account of the breeding of two species of humming birds in Trinidad—*Trochilus colubris* and *Florisuga atra*. His remarks, however, are mainly confined to a pair which had built on the bracket of a lamp hanging over the door of Lady Northcote's residence. Though the lamp contained a powerful electric light which was frequently turned on during the night so as to shine full into the nest, the birds yet elected to stay, although when sitting the hen was but a few inches from the globe! The more easily to keep a watch on the progress of the family a mirror was arranged over the lamp.

From Lady Northcote's notes it would appear that incubation took at least seventeen days, instead of the normal ten or twelve. This extended period is, probably, as Mr. Ingram suggests, due to the many alarms which the bird suffered when sitting.

Breeding of Rheas in the Zoological Gardens.

Once again the Rheas in the gardens of the Zoological Society have brought off nestlings; and all who are interested in the problems of the coloration of nestlings should take the first opportunity of inspecting these youngsters.

Unfortunately they cannot be compared, side by side, with the young of Darwin's Rhea, for the nestlings of these two species differ very markedly, the latter being very conspicuously striped, having a longer and more silky down, and a dull grey median stripe along the underside of the body.

Gadwall Breeding in Scotland

Mr. H. B. Marshall, in the *Field*, July 28, records the fact that a pair of Gadwall have succeeded in bringing off a brood in a small lake at Broughton, Peeblesshire the first record of such an occurrence in Scotland, where the Gadwall hitherto has occurred only as a winter visitor.

Pelican and Spoonbill in Norfolk.

Mr. J. H. Gurney writes to the *Field*, August 4, to say that a Pelican was seen on Breydon Water, Great Yarmouth, by Mr. Arthur Paterson, a well known and experienced naturalist. About four hours after its arrival it was joined by a Spoonbill. The Pelican stayed till the next day, when, early in the morning it made off in the direction of the sea. Another Spoonbill, by the way, appears to have been seen on Breydon Water on April 28 of this year.

Though Mr. Gurney thinks the visit of this Pelican may be that of a wild bird, he suggests that it may also have escaped from some private collection. But the loss of such a bird should soon be known.

Rare Variety of the Jackdaw.

A rare variety of the Jackdaw is described in the *Field*, July 28, by Mr. H. Beveridge, of Sprouston, N.B. This bird, which he shot on July 15, had the head bright chestnut; neck, light buff; back and breast, bright chestnut, the back slightly mottled with black. The wing and tail feathers had a bronze sheen, but were otherwise black. "He is an old cock bird," he remarks, "in full plumage, and in every other detail is exactly like other Jackdaws. One thing I noticed, whenever he approached his neighbours they invariably hunted him away."

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

The Radiation from a Welsbach Mantle.

ONE of the most interesting if perhaps not the most popular discussions at the recent British Association meeting was on the above subject. It was led off by a spirited challenging paper by Mr. J. Swinburne (who was unfortunately absent), in which a sketch was given of the various suggestions which have been made from time to time to explain the high efficiency of a Welsbach mantle, and the arguments for or against them were outlined. Dr. H. Rubens, of Charlottenburg (whose recent experiments have already been sketched in these columns), followed with an account of his experiments, and also of a demonstration of one of them. Light from an electric lantern is focussed on a cold Welsbach mantle so as to brilliantly illuminate it, and the reflected light is then focussed on a screen, where it forms an image of the mantle. A cell containing copper sulphate solution is interposed so as to isolate the blue rays. If now the mantle be made luminous by means of gas from the burner in the usual way, the reflected image on the screen is much less bright than before, instead of being brighter as might have been expected. The explanation is that at the higher temperature the mantle is a much worse reflector for blue rays than when cold. When a red cell is interposed, the effect on the screen is a little greater when the mantle is hot than when it is cold. When the mantle is cold, its reflecting power is comparatively large, and hence its radiating power is small for blue light. It is by no means a full radiator for such light. But when the mantle is heated its reflecting power diminishes; its radiating power for blue rays must therefore increase. This effect is not obtained for red light, and by inference we may suppose that for infra-red radiation there is no increase of radiating power when the mantle is hot. The bearing of the experiment on the behaviour of a Welsbach mantle is obvious. Such a mantle is nearly white when cold; this being so, we might expect it to be a poor radiator of all kinds of radiation; it is from a black body that most radiation is expected; so much so that the perfect radiator is usually (though rather curiously) known as "a perfectly black body." But radiating power for the more luminous radiations increases with temperature; hence at any high temperature the proportional amount of luminous radiation is greater than at any low temperature. Thus the mantle remains at high temperatures a bad radiator for most radiations, and is therefore able to reach a high temperature when immersed in a flame. Its great luminous efficiency is to be traced, therefore, to the combined action of this high temperature and the increased radiating power for luminous radiations. In the discussion which followed, there appeared to be a diversity of opinion as to what Dr. Rubens' experiments proved. One speaker congratulated Dr. Rubens on having demolished Mr. Swinburne's contentions; another considered that Rubens and Swinburne were in practical agreement (although Swinburne did not lay enough emphasis on the existence of selective radiation). With the latter opinion Dr. Rubens concurred. The outcome of the discussion is to show that to account for the efficiency of the mantle, there is no need to invoke the operation of chemical changes or phosphorescence. Dr. Rubens, when questioned, was not disposed to deny the presence of such additional phenomena. They may be present even in the case of a thoria-ceria mantle, with which his experiments were mainly concerned; in the case of others they may be present to a greater degree. But he considered the evidence wholly against attributing the main phenomena to these causes. The difference between the opposing views may be brought out by indicating that according to the temperature explanation, the total radiation from the thoria and ceria is equal to the sum of the radiations *at the actual temperature of the mantle* which would be emitted by the separate thoria and ceria *at the same temperature;* while on the chemical hypothesis a radiation appears as the result of combining the thoria and ceria which would not be present if these materials were separate.

The discussion, which was of a somewhat recondite character, was enlivened owing to Mr. Swinburne having sent replies to possible speakers. These were read, and, being in Mr. Swinburne's characteristic style, they helped to relieve the tension.

Is an Alpha Particle Initially Uncharged?

This question was the subject of a paper at the British Association by Mr. F. Soddy. Several attempts have been made previously to give a satisfactory answer to it. When an Alpha particle is ejected from radium emanation, does it go away charged or is it at first uncharged, acquiring a positive charge afterwards by impact with the particles of air which it ionises? It is certainly a most fundamental question, because our views of the ultimate constitution of matter are likely to be very different according to the character of answer given to it. Tremendous difficulties meet the experimentalist in endeavouring to discover the real state of things. It is essential that the Alpha particles tested should have had no chance of colliding with other matter before the test is made. This involves that they shall be allowed to move only in the highest attainable vacuum, and also that they shall be emitted from a radio-active substance which is not more than one molecule thick. The latter condition can be satisfied by dealing only with the decomposition of radium C, which can be deposited in a calculable amount upon the walls of a vessel. But the attainment of a sufficiently high vacuum presents enormous difficulties. In an ordinary Rontgen ray vacuum, there are probably still something like one hundred millions of millions of molecules in every cubic centimetre, and even if the vacuum can be pushed one hundred million times further, there are still one million such particles present; so that an Alpha particle penetrating through one centimetre length of such a "vacuum" would encounter one hundred molecules. Mr. Soddy considers that he has sufficiently overcome this difficulty. The test of charge employed by him is the magnetic deviation of the Alpha stream. Conditions were arranged so that the stream was completely deviated under ordinary conditions and, with the magnetic field excited, did not succeed in escaping from the capillary tube in which the active deposit of radium C had been laid; and the experiment consisted in testing whether any deviation (arising from the supposed charge of the stream) took place when the vacuum was made as high as possible. Long series of results, all of which indicated possession of a positive charge, led to successive improvements of the conditions; and, in the end, such conditions were obtained that the stream *underwent no deviation*. The requisite condition for obtaining this result seemed to be that the emanation should be left for as short a time as possible in contact with the glass, which it gradually modifies, producing a black deposit in it. If this result is accepted as unequivocal, the conclusion necessary is that the Alpha particle is initially uncharged. Mr. Soddy himself does not seem quite confident in his explanation of the repeated failures, and until any such doubt is cleared away it is premature to make any revolutionary change in our conception of what goes on in radio-active changes. There are undoubtedly difficulties in either view. The great difficulty in considering the charge as being possessed from the beginning of the isolated life of the Alpha particle, is that not only would the particle take away a positive charge, but in many cases it also leaves behind a positive charge. Now the simultaneous production of equal amounts of positive and negative electricity would seem to be as necessary as the simultaneous production of two ends to a string in cutting it. Many of us had thought that this difficulty had been completely removed in the fairly recent discovery of slow moving negatively charged emissions (already referred to in these columns). It is well known that the characteristic electric phenomena of radio-active change do not take place unless the particles discharged have a velocity higher than a certain critical one. Any amount of discharge of negative electrons may, therefore, be taking place without any sign of it being detectable by our electrical instruments. If the positive Alpha particle leaves behind a positive substance which simultaneously emits slow moving negative electrons (corresponding in some respects to the slow moving gases which are ejected from a Roman Candle at the same time as the ball), the fundamental laws of classical electricity will be satisfied. A similar explanation may of course be made to account for the positive charge of the residue, even if the Alpha particle goes away uncharged. But in this case we have to account for the subsequent production of a positive charge. If it acquires it from a gas molecule which it ionises, the negative that remains must not be forgotten; any region completely through which a flight of positive charges has taken place will be left negatively charged, though to an amount which is at present too small to be detected. The writer believes that Mr. Soddy is of opinion that his views are about to lead to an overthrow of the fundamental laws of electricity. Mr. Soddy has, on another occasion, suggested as much. The present writer would urge all who are thinking about this subject never to forget that it has been definitely shown experimentally that in the sum total of radio-active charges which occur inside a closed space, the total amount of electrification produced is zero.

ZOOLOGICAL.

By R. Lydekker.

The Sleep of Animals.

Since there is very little of general interest to record in the matter of pure zoology, I venture to devote my first two paragraphs to subjects properly coming under the designation of physiology. Sleep is an attribute common to all the more highly organised terrestrial animals (although whether whales and dolphins ever slumber is still unknown); and there are quite a number of mammals which become torpid for a longer or shorter period, either during the drought and heat of a tropical summer, or in the cold weather of the northern winter. As regards the cause of that suspension of consciousness which we call sleep, recent investigations indicate the probability of the existence in the brain of a "break-and-make" action. When the whole apparatus in connected, the brain is in full working order; when the disconnection is made, sleep is the probable result. The active working power of the brain lies in certain nerve-cells; from these spring nerve-cords, which in their turn divide and sub-divide till they terminate in small knobs. Formerly these nerve-cells were supposed to be in permanent connection by means of their terminal branches; but now it appears that the terminations of these branches are only in apposition, and are capable of being separated. The fact that narcotic substances induce it is an almost convincing proof that such separation is the immediate cause of slumber. It is added by Sir William Gowers, who has lately developed and explained the new theory, that by its means we are readily able to explain the phenomenon of sleep-walking.

Fish Out of Water.

It is well known that certain kinds of fishes are able to live out of water much longer than others; the power being dependent upon the length of time that their gills are capable of remaining damp. So long as this condition lasts, fish are able to obtain the necessary amount of oxygen from the air through the medium of the water spread over the fine membrane of the gills. Recently a German has invented an apparatus by means of which the gills can be kept moist for an indefinite period. This apparatus consists of a wooden box, with a number of compartments corresponding with the size of the fishes. On the floor of each compartment is a layer half an inch deep, of cloths saturated with water, which by evaporation keeps the atmosphere moist. The gills of the fishes are thus kept damp; while oxygen is supplied from a receptacle outside the box. Many kinds of fresh-water fish have, it is said, been kept alive for from three to four days, by means of this ingenious invention.

The Fossil Reptiles of Africa.

The extinct reptiles of South Africa are among the most wonderful in the whole world, and have attracted the attention and interest of a number of the most distinguished palæontologists; and well they may, seeing that they include among them the undoubted ancestors of mammals, although this ancestral group is by no means confined to the great southern continent of the Old World. One of the latest workers on this fauna is Dr. R. Broom, Professor of Geology and Zoology at the Victoria College, Stellenbosch, who has lately published a paper on these reptiles under the serial heading of *Science in South Africa*. All who are interested in a very interesting subject should make a point of consulting this excellent little *resumé*.

Freshwater Faunas.

As was remarked, in connection with the "Broads," in the last presidential address to the Norfolk and Norwich Naturalists' Society, much work remains to be done before we can consider our knowledge of the inhabitants of even our own freshwaters in anything like a complete or satisfactory condition. If this be the case with the freshwaters of Great Britain it is, *a fortiori*, much more so with those of the tropics. Naturalists should therefore be pleased to learn that Dr. Nelson Annandale, Deputy Superintendent of the Indian Museum, Calcutta, has commenced a systematic investigation of the freshwater faunas of India, the results of which are in course of publication in the Journal of the Asiatic Society of Bengal. Although only seven parts of this memoir have appeared—and these very short ones—Dr. Annandale has already been enabled to record certain discoveries of very considerable interest. He has, for example, obtained an aquatic cockroach (*Epilampra*), belonging to a group previously known only from the Malay States and Borneo. More interesting still is the discovery of an aquatic weevil, since no representative of this group of beetles with habits of this nature has hitherto been known. This weevil, which is not even generically identified, feeds upon a particular kind of water-plant; and Dr. Annandale has fortunately been able to describe its complete life-history.

British Biting Flies.

In connection with insects, reference may be made to the publication by the British Museum of a beautifully illustrated monograph of the blood-sucking flies to be met with in the British Islands; mosquitoes and gnats, as well as horse-flies, etc., being included in the work. The feature of the work (for the text of which, Mr. E. A. Austen is responsible) is the enlarged coloured figures of a considerable proportion of the species.

CORRESPONDENCE.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

DEAR SIRS,—In your current issue Mr. Porter draws attention to the fact that an image may, under certain circumstances, be seen by converging light reflected from a concave mirror. This is interesting, but the instance is not by any means an isolated one. The image may also be seen with an ordinary convex lens, which is, of course, theoretically similar to a concave mirror. To observe this, place a lighted candle behind the lens at a distance greater than the focal length, and view from a point between the lens and the real image of the candle. The observed image is erect, and is still visible when the eye is drawn close up to the lens. It is, in fact, nothing more or less than the ordinary image seen by all persons who wear convex spectacles.

The mirror phenomenon is brought into line with text-book optics if we regard the mirror and the lens of the eye as together forming an optical instrument which throws a real image of the candle on the retina.

Yours truly,

Sheffield University, LEONARD SOUTHERNS
August 16, 1906. (Whit. Schol.).

[The image referred to must, of course, be obtainable from any optical system producing a real image by means of rays of small convergence. The comparison with the ordinary use of spectacles is, I think, rather misleading. Convex spectacles for distant vision are employed when the wearer is able to focus *only converging* pencils. One object of my note was to indicate that the power of forming a tolerable image by means of converging pencils is common to those who are not really long sighted. For example, I am quite unable to accurately focus the stars, but images formed as above are tolerably good. I do not concur in the last paragraph of Mr. Southerns' letter, because it fails to recognise that the images are *usually* imperfect.—A.W.P.]

REVIEWS OF BOOKS.

ASTRONOMY.

A Compendium of Spherical Astronomy, with its applications to the determination and reduction of positions of the fixed stars, by Simon Newcomb (New York and London: Macmillan Co., 1906; pp. xv + 444; 12s. 6d. net). This is the first of a projected series designed both for the student and the investigator, supplying the one with a condensed handbook which takes very little account of branches of purely theoretical interest, and the other with a *vade mecum*, containing just those formulæ and data which are necessary for the working out of practical applications by the shortest or most convenient method, thus saving what is often the most irksome part of his labour, which may be called "sparring for a hold." Part I. contains such general preliminaries as Approximations, Interpolation, Method of Least Squares, and Probable Error; Part II., Spherical Co-ordinates, Conversion to Different Axes, Solar and Sidereal Time, Parallax, Aberration, Refraction, Precession, and Nutation, having regard to the comparatively long periods now covered in catalogue comparisons. This last point is still more strongly emphasised in Part III., which deals with the actual reduction of stellar observations for epoch and apparent place, and also, of course, to the meridian, and with the comparison of catalogues and deduction of proper motions. A list of independent catalogues is given at the end of Part III., and an appendix follows giving tables for nearly every purpose referred to in the volume, and constants and formulæ in frequent use. Altogether a very valuable book, which we can confidently recommend.

BOTANY.

School Gardening for Little Children, by Lucy R. Latter (Swan Sonnenschein and Co.; 2s. 6d. net.)—An excellent little book, brimful of exactly the proper kind of information required by those whose duty it is to train children to observe and draw deductions for themselves. The garden proper is not the only thing utilized for the purpose of imparting information; the various forces that enable a garden to exist—light, heat, rain, wind, &c.—are also included, and the effect of each in turn furnishes an object lesson, hence the child is introduced unconsciously, and in the pleasantest of ways, to the elements of botany, physics, zoology, and, above all, the power of observation.

The wisdom of teaching what must at some time be unlearned is, perhaps, doubtful, and to a mind that is receiving first impressions, such terms as "seed-box," for fruit, "dust spikes," for stamens, and "sticky-head," for stigma, are not more explicit, neither more easily remembered, than the proper names of these structures.

PHOTOGRAPHY.

The Hand Camera Companion and Guide. Edited by the Rev. F. C. Lambert, M.A. (London: Hodder and Stoughton, 1906; 1s. net).—On the title page Mr. Lambert appears as the author, and presumably as these words are generally understood he has been more of an author than an editor in preparing this volume. Mr. Lambert is essentially a clear writer and well understands the beginner's wants. In a series of headed paragraphs he discourses concisely on hand cameras and their various parts, making negatives and printing from them, and the application of the processes described to all sorts of subjects. The page headings are carefully selected and there is a good index, so that although the work is not divided into chapters it is easy to find any required section. The volume contains a great many practical hints and useful suggestions that are not often found in print, and is well worth study by those who use, or are about to use, hand cameras.

The Photographic Picture Post-Card. By E. J. Wall, F.R.P.S., and H. Snowden Ward, F.R.P.S. **Magnesium Light Photography.** By F. J. Mortimer, F.R.P.S. (London: Dawbarn and Ward. 1s. net, each.)—Judging from the recent output of various publishers, the demand for small volumes dealing with just one section of photographic work seems to be increasing. This method of dispensing information, although not without its disadvantages, enables the buyer to get what he wants as he wants it, and often makes it possible for the publisher to secure a specialist as author. Perhaps the chief objection to subdividing the subject and attempting to make each part complete in itself, is that there must be a large amount of overlap or of omission, for photography is one, whether magnesium light or daylight is used, and whether the print be a post-card or otherwise. Both these recent additions to one of Messrs. Dawbarn and Ward's series, are by men of practical experience in the subjects they treat of, and may be safely accepted as guides. The treatise on picture post-cards is divided into two parts: first, the making of them, and second, the making of money from them; and both volumes deal with the business or commercial side of the subject as well as the more strictly photographic side. The authors have made a judicious selection of subjects to treat fully, and have not omitted to refer to alternate processes.

PHYSICAL CHEMISTRY.

Higher Mathematics for Students of Chemistry and Physics. J. W. Mellor (Longmans; 15s. net.) The rapid growth of physical chemistry has taught the chemist that unless he is equipped with a sound working knowledge of mathematics he stands at a disadvantage so great that he is practically excluded from a considerable region of his subject. The man who desires to go behind mere experiment to the general laws which enable results to be classified must acquaint himself with mathematics, for it is only in terms of mathematical symbols that these relations can be concisely expressed and deductions from them made. This book, which now appears as a second and considerably enlarged edition, is intended to provide such a selection from the various departments of mathematics as may subserve the needs of such a student. It is not for the mathematical specialist, and consequently what the author considers "tedious demonstrations" are sometimes avoided by merely making reference to the "regular text-books." The aim throughout is to make the student alive to the real meaning of mathematical expressions by means of examples selected from work with which he is otherwise familiar.

Although it is probably the chemist who will be most attracted, a great number of the problems are of a purely physical nature. It is doubtful whether it was worth while to cater for the physicist, who presumably will receive a training in a more formal way; but, of course, many will be glad of the assistance which the book affords. And to them we would say that there is no branch of physics which does not contribute to the examples here analysed. The chemist would find it more useful if many of these problems were not present. The book appears to be carefully edited; we have noticed only a few misprints. But in some places the sentences might be made less ambiguous if re-written differently.

SCHOLASTIC.

A Guide to the Electrical Examinations. F. H. Taylor, A.M.I.M.E. (Percival Marshall and Co., 1s. net, paper; 1s. 6d. net, cloth.) The examinations referred to are those of the City and Guilds Department of Technology, and of the Board of Education. Besides general particulars and syllabuses the book contains selected questions from recent examinations, many of which are worked out in detail; it contains also hints on the preparation for examinations and on the working of examination papers. A considerable amount of condensed information is provided.

Elementary Modern Geometry. H. G. Willis, M.A. Part I (Clarendon Press, Oxford, 2s.) These lessons are, in part, experimental, in part theoretical. The modern idea is followed according to which it is sought first to familiarize a student experimentally with the more important theorems and problems; he is then in a better position to understand the more strict mathematical logic by which they are later on examined. With this method we are in thorough agreement, though we recognise that there exist those to whom it will be very repugnant. No attempt has been made to follow Euclid's sequence.

Examples in Physics. C. E. Jackson, B.A. (Methuen, price 2s. 6d.) This book will prove very valuable to the teachers in secondary schools, as it provides a very large number of problems ranging in difficulty from those of very elementary kind to many of a more advanced kind suitable especially to those who are reading for University Scholarships. None of these problems are worked out as illustrations; hence the book cannot be used alone. Besides several sets of examples arranged according to subject, there is a series of problem papers in which mixed examples are given. Answers are provided only to the former. We think that it would be better to provide answers to all. In those cases in which a teacher may wish to set questions for special test purposes it is very easy for him to slightly alter the numerics so as to prevent the student getting a "lead." The presence of answers makes for utility to the private student.

ZOOLOGY.

Serials. — We have to acknowledge the receipt of copies of the first two numbers (May and June) of a new scientific serial, the (Haslemere) *Museum Gazette*, whose special purpose is to forward the interests of objective education and field study. Many of the articles in the first number are excellent, and there are some good photographs in both. We fear, however, that the articles on camels and deer and on gnus in the second volume are scarcely calculated to impress naturalists with the value of the new teaching. We are told, for instance, in the first of these, that camels and deer form a single family of ruminants, and that adult camels have no upper incisors and pair less of lower ones than giraffes. This blunder is, however, eclipsed by the following sentence: "All the gnus are South African and would appear to bear the same relation to the buffaloes of that continent that the North American bison does to the American buffalo."

We have also received from the University of California copies of papers on the ostracod crustaceans, of the family *Halocypridæ*, on the shore-anemone, *Bunodactis xanthogramma*, and on sexual dimorphism in the hydroid polyps of the genus *Aglaophenia*. The dimorphism in the latter group displays itself in the plumules.

The Menageries of Europe. — Captain Stanley Flower, Director of the Zoological Gardens at Giza, Egypt, has favoured us with a copy of a report of a mission undertaken by himself last year to visit the chief Zoological Gardens in Europe, in which much interesting information with regard to these establishments and their inhabitants will be found.

MISCELLANEOUS.

Thought - Transference, by N. W. Thomas, M.A. (De La More Press; pp. 212 and index, 3s. 6d. net). This work is a critical and historical review of the evidence for telepathy, and records a number of new experiments carried out in 1902 and 1903. It is full of interesting and thoughtful matter on this much-discussed subject, and will afford much entertainment and food for thought to those who have attempted at any time to unravel some of its tangled problems.

E. A. M.

Crystal-Gazing, by N. W. Thomas, M.A. (De La More Press; pp. 159 and index, 3s. 6d. net). This work has an introduction by Andrew Lang, and gives a history of the practice of crystal-gazing. The subject is dealt with from a critical point of view. A crystal does not seem to be always a necessity, the mental image resulting being capable of production merely through intent gazing into many other more prosaic substances. An interesting experience in connection with Mr. Balfour and Miss Balfour is related in Mr. Lang's introduction. E. A. M.

The Unity of Will, by George Ainslie Hight (London: Chapman and Hall, 1906; 10s. 6d. The author's aim is ambitious, inasmuch as he endeavours to provide us with a new philosophy, a task for which, to our thinking, he is but indifferently qualified. There is a lack of cogency in his arguments, while in many cases he absolutely misinterprets, and misrepresents; as for example, when he defines Agnosticism as "denying and reviling all gods." His chapter on the "Sophistries of Science," seems to us crude. Imbued with what he calls "the divine teaching of Plato," an ardent disciple of Schopenhauer, and a "Vedântist," he looks on the world through distorted glasses, and would have us believe that what *he* sees is true, and only that!

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Use of the Camera Lucida.

THERE are several ways of recording the appearance of an object as seen in the microscope. Of these the photo-micrograph is considered the most trustworthy, as it gives no variation with regard to the powers of observation and individual opinions of the observer, powers of observation which vary with the observer's skill and experience, and opinions which too often enable him to persuade himself to see what he wishes to see, and which bias him accordingly by preformed hopes or expectations. From the result of personal idiosyncrasies of this sort the photo-micrograph is free, and it has even a peculiar property of its own in increasing slightly the resolving and, therefore, the defining power of an objective, but it has none the less great disabilities. It takes no account of variations of focus, and the higher the power and the greater the aperture of an objective, the more is the resulting photograph limited to a single plane, with all that this involves. It also takes no account, or even an apparently distorted account, of differences in colour, and an object which has been carefully differentiated by selective stains for visual examination may, as a photo-micrograph, be confused and misleading in spite of all the colour screens and mono-chromatic methods of illumination that experience can suggest. Therefore we are frequently thrown back on the pen and pencil as a means of recording what we see for future reference or for the information of others.

For such pen and pencil methods the simplest plan of all is to look down the microscope tube with one eye and to record the result upon a piece of paper placed conveniently at one's right hand. But the drawbacks of such a method of procedure are manifest, and not the least of these is the difficulty in keeping the details in place and in proportion. The methods used, therefore, come under two heads—the projection of the image bodily upon a sheet of paper, and the tracing of it there *in situ*, or the use of an apparatus which enables us with one and the same eye to see both the image and the paper, and to draw each line of the former in its proper position.

The projection method requires the use of a projection microscope, an enclosed light, a darkened room, and preferably a right angle prism to project the image down upon the paper as it lies upon the table, though I have seen more or less unsatisfactory attempts made to do this by means of a prism, such as the Wollaston prism, attached merely to the eye-piece of the microscope. It is fairly successful with low powers, but with high powers the loss of light is prohibitive, to say nothing of the other disadvantages inherent in this method.

The camera lucida as ordinarily used brings the microscopical image and the paper into view at the same time and in the same place. Of the many forms of apparatus the simplest, the least expensive, and in some hands not the least satisfactory, is Beale's well-known form. As originally designed by Amici this was a piece of plain glass set at an angle of 45° across the eye lens of the ocular, the tube of the microscope being placed in a horizontal position and the observer looking down through the glass at the paper beneath. By this means he saw the paper directly, whilst the microscopic image was reflected up into his eye. There was, however, a troublesome and, indeed, fatal double reflection from the inner surface of the glass, and Dr. Beale got over this difficulty by the simple expedient of using tinted glass. Such a camera lucida can now be bought for a few shillings, or can even be home-made by anyone possessed of a little ingenuity. Its main defect is that the image is inverted though not transposed, and this renders the subsequent filling in of details more troublesome and more liable to error and confusion.

Wollaston's camera lucida is a form that was early introduced, and in many hands has also done good work, but is now more or less obsolete. It consisted of a prism covering the whole of the eye-lens of the ocular, and this prism was so constructed that it gave two reflections and so transmitted the image to the eye neither inverted nor transposed. The microscope was used in the horizontal position, and the eye was so adjusted that half of the pupil looked into the prism and the other half down upon the paper. Any variation in the position of the eye, therefore, caused the two fields of view to become unequally illuminated, and the difficulty of keeping the eye rigidly in the necessary position caused this form of camera to fall into disuse as other and better forms were evolved.

The camera lucida most used nowadays is that designed or adapted by Abbe. It consists in its simplest form of a ring to clamp around the eye-piece end of the microscope, this ring carrying a projecting arm to which is attached a mirror set at an angle of 45° or so with the axis of the microscope. This mirror reflects the image of the paper into a small silvered mirror placed above the ocular, thus reflecting the paper into the eye. This latter mirror is perforated by a small circular hole which enables the eye at the same time to look directly down the microscope tube; in fact, the eye is really looking through a cube of glass cut diagonally and with one of the diagonal surfaces silvered and pierced as just described.

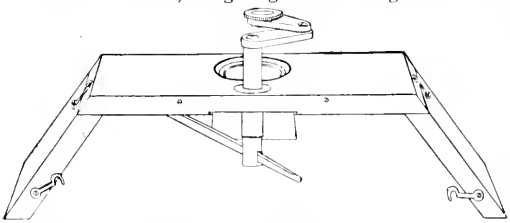
The same principle is adopted in the combined camera lucida and eye-piece sold by most opticians, which, though less effective, are certainly more compact, a mirror much reduced in size or a prism taking the place of the large Abbe mirror.

In all forms of camera lucida, other than those of the direct projection type, the great difficulty is the adjustment of the illumination so that neither microscopic image nor paper overpower each other in brightness, the former varying greatly according to illuminant, condenser, diaphragm, and magnification, whether of objective or ocular. To avoid this, Abbe's camera lucida in its most elaborate, and, unfortunately, its most costly form, has a system of differently tinted glasses, one set of which is used to adjust the brightness of the image from the paper, and the other set to adjust the brightness of the microscopic image. There is also a change of prism above the ocular with a different aperture for use with different objectives, and even an elaborate centring mechanism.

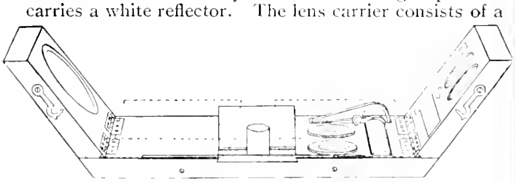
The use of the camera lucida always requires a certain amount of practice, but the initial difficulties will be rapidly overcome if the necessity for careful adjustment of the two illuminations is borne in mind. The differently tinted glasses are of great service, and much can be done by careful adjustment of the condenser diaphragm, but, perhaps, the most useful hint that can be given to the beginner is to suggest the use of two lamps—one to illuminate the paper and one to illuminate the microscope. A little juggling with the two lamp-wicks will often work wonders. Another suggestion that can be made is to blacken the end of the pencil or to tip it with gold-leaf. Finally, distortion of the drawing must be guarded against, especially with forms like the Abbe apparatus, which can be used with the microscope slightly inclined, and, if necessary, an inclined drawing-board must be used.

New Portable Dissecting Microscope.

Messrs. R. and J. Beck have brought out a new dissecting microscope which is not only portable, but when folded up contains all the necessary apparatus packed into the thickness of the wood, so that there are no projections or loose pieces. The illustrations make the principle clear, the two side flaps, which spread out as rests for the hands, being hinged and folding back when



not in use. The wooden table has a circular aperture into which drops a white porcelain saucer, which is concave on one side and flat on the other, and can be used either way up, or a piece of transparent glass may be used in place of the saucer, in which case light may be thrown from below by means of a folding flap which carries a white reflector. The lens carrier consists of a



tube which fits into a socket in the table, and carries a double arm by means of which the whole aperture can be examined. The vertical adjustments are made by means of a lever. The whole apparatus, with two single lenses, saucer, glass plate, focussing adjustment, and two needles packs into a space 9 ins. by $3\frac{3}{4}$ ins. by $1\frac{1}{8}$ in., and costs 35s.

A New Application of the Abbe Condenser

The "Journal" of the Royal Microscopical Society summarises some observations of a Continental worker which are based on the fact that the Abbe condenser presents a real, reversed image of the source of illumination. If an object, such as a micrometer scale, be suitably interposed, an image of this will be similarly formed on the stage, and may be applied to measuring an object there. In this way, by the help of a proportionately stronger objective, a series of magnifications can be obtained which are very convenient for drawing, and for the preparation of various objects. The size of the image formed above the front lens (viewed from above) of the condenser depends on the distance of the object from the under-lens; the image is smaller as the distance is increased. Thus it will be seen that the series of magnified images thrown on to the stage will vary from zero to a maximum. This image can be combined with various powers of objective, eye-piece, and tube-length, and thus the series of attainable effects is practically infinite, although only observations in the middle of the field will be free from sensible distortion. Instead of the condenser, weak achromatic objectives might be used. A difficulty would, no doubt, lie in the construction of a suitable adjustable stage for the object; the author, however, sees his way to a proper design. He summarises the advantages of this proposal as:—(1) The facility for orientating objects which can be afterwards examined in the usual way. (2) The formation of graduated magnifications by which an operator who wishes to draw from a weak magnification can easily select the most suitable power. (3) The property possessed by the Abbe (thus used) in combination with an objective of forming an erect image. (4) If a plane mirror be used, and the object inserted between the light-source and the mirror, an erect microscope becomes virtually a horizontal one, and may thus be used, for example, as an aquarium microscope. (5) As the magnification may be zero, the arrangement may be applied to the drawing of objects in their natural size.

Temporary Mounting of Objects.

It often happens that objects are required to be mounted temporarily only, and without the more elaborate processes which are necessary for permanent mounting. Such objects can be mounted in a drop of the preservative, or in water, or in alcohol and formalin according to the medium in which the object may be, whilst normal salt solution (common salt .6 per cent. in water) is often of great use. Living objects are best mounted in their natural medium, as any change may alter their appearance, or, at least, inhibit their movements. In all these cases, however, rapid evaporation of the liquid takes place, and some means of sealing the cover-glass is necessary. For this purpose vaseline, castor-oil, or glycerine jelly have all proved useful, and a method that is of service in many cases, especially where what are known as "hanging drops" are being dealt with, is to use a paraffin match, or a toy wax candle by blowing out the light, and whilst the paraffin is still liquid running it like a brush along the edge of the cover-glass. In all cases it is necessary to have sufficient of the mounting medium to prevent soft objects from being crushed, and, on the other hand, to avoid any excess which would cause the cover-glass to float, or to spread beyond the edges. Such surplus can readily be removed with blotting paper, care being taken lest the capillary attraction draws too much liquid from beneath the cover-glass. It is well to lower the cover-glass edgewise gently upon the object in order to avoid bubbles.

John Wheldon and Co.'s Catalogue.

Messrs. John Wheldon and Co., of 38, Great Queen Street, W.C., have just issued a catalogue of books and papers on Microscopical Science in all its branches, which contains many interesting items, including numerous books on the microscope itself.

Microscopical Material.

Mr. J. Sculthorpe, of Bath, has kindly sent me for distribution a considerable quantity of sea-sand from an unknown locality, which well repays looking over under the microscope, and from which interesting marine débris can be picked out. I shall be glad to send an ounce or two of this to anyone who applies for it. Applications must be accompanied by a stamped and addressed envelope, a wooden or tin box, and the coupon to be found in the advertisement pages of this issue.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for September.

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

THE SUN.—On the 1st the Sun rises at 5.12 and sets at 6.47; on the 30th he rises at 6.0 and sets at 5.41.

The Sun enters the sign of Libra on the 23rd at 11 p.m., when autumn commences.

The equation of time for sundial purposes is negligible on the 1st and 2nd, hence these dates are convenient for the adjustment of dials, as only the longitude correction is needed. Sunspots may usually be observed on the Solar disc, but there is a noticeable diminution both in number and size, indicating that we are well past the maximum.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Sept. 3 ..	21° 41′ E	7° 14′	280° 22′
,, 8 ..	22° 51′ E	7° 15′	214° 17′
,, 13 ..	23° 52′ E	7° 13′	148° 17′
,, 18 ..	24° 43′ E	7° 7′	82° 17′
,, 23 ..	25° 24′ E	6° 57′	16° 17′
,, 28 ..	25° 56′ E	6° 47′	310° 19′

THE MOON:—

Date.	Phases.	H. M.
Sept. 2 ..	○ Full Moon	11 36 p.m.
,, 10 ..	☾ Last Quarter	8 54 p.m.
,, 18 ..	● New Moon	0 34 p.m.
,, 25 ..	☽ First Quarter	6 12 a.m.
,, 10 ..	Apogee	0 54 a.m.
,, 22 ..	Perigee	0 18 a.m.

OCCULTATIONS.—The following are the particulars of the principal occultations visible from Greenwich; it will be noticed that the 1st magnitude star Aldebaran suffers occultation on the morning of the 10th:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
Sept. 9	75 Tauri.. ..	5·3	p. m. 10 19	43°	p. m. 11 7	286°
,, 9	B.A.C. 1391 ..	4·9	11 14	116°	11 58	211°
,, 10	α Tauri	1·1	a. m. 2 27	149°	a. m. 2 43	174°

THE PLANETS.—Mercury (Sept. 1, R.A. 9^h 31^m; Dec. N. 15° 3′; Sept. 30, R.A. 12^h 43^m; Dec. S. 3° 38′) is in superior conjunction with the Sun on the 24th, and hence is unobservable towards the end of the month; during the earlier part of the month the planet is a morning star in Leo, and being near the point of greatest elongation is favourably placed for observation. On the 9th the planet rises at 4.2 a.m., whilst on the 6th he is situated about 1° north of Regulus.

Venus (Sept. 1, R.A. 13^h 25^m; Dec. S. 10° 28′; Sept. 30, R.A. 15^h 16^m; Dec. S. 22° 13′) is at greatest easterly elongation of 46° 29′ on the 20th. During the month the planet moves from an apparent position close to Spica on the 1st to one in Libra on the 30th. As seen in the telescope the planet has the phase of "half moon," 0·51 of the disc being illuminated. On the 15th the planet sets at 7.25 p.m.

Mars (Sept. 1, R.A. 9^h 43^m; Dec. N. 14° 58′; Sept. 30, R.A. 10^h 53^m; Dec. N. 8° 26′) is a morning star in Leo, rising about 3.30 a.m. throughout the month. The planet is in conjunction with Mercury on the morning of the 5th, Mercury being 10′ to the South.

Jupiter (Sept. 1, R.A. 6^h 26^m; Dec. N. 23° 2′; Sept. 30, R.A. 6^h 42^m; Dec. N. 22° 51′) is a morning star in Gemini, rising about 10.45 p.m. on the 15th.

Saturn (Sept. 1, R.A. 22^h 57^m; Dec. S. 9° 1′; Sept. 30, R.A. 22^h 49^m; Dec. S. 9° 50′) is an evening star describing a retrograde path in Aquarius, and is well placed for observation, being due south at 11 p.m. on the 19th, when he rises at 5.45 p.m. The planet is in conjunction with the moon on the morning of the 3rd, at 3 a.m.—the Moon being "full." As seen in this country, the planet will appear to be about 1° 15′ from the northern limb of the moon, as shown in the diagram.

We are looking on the northern surface of the ring, the outer major and minor axes of which are 44″ and 4″ respectively, whilst the apparent diameter of the ball is 17″·6.

The planet is in opposition to the Sun on the 5th at 3 a.m., hence near this date he is on the meridian about midnight.

Uranus (Sept. 15, R.A. 18^h 20^m; Dec. S. 23° 41′), though rather low down in the sky, is fairly well placed for observation during the early evening, and is due south shortly after sunset. The planet is situated in Sagittarius in a part of the sky devoid of good reference stars, though the star μ Sagittarii is some 3° to the N.W.

The planet is at the stationary point on the 14th, after which his motion is direct or easterly, whilst on the 28th he is in quadrature with the Sun, and hence near this date he crosses the meridian about 6 hours after the Sun.

Neptune (Sept. 15, R.A. 6^h 53^m; Dec. N. 22° 0′) rises about 11.15 p.m. near the middle of the month, and hence is not in a favourable position for observation before midnight; the planet is situated about 1° north of the star ζ Geminorum.

Minima of Algol occur on the 10th, at 10.48 p.m., and on the 13th, at 7.37 p.m.

TELESCOPIC OBJECTS:—

Double stars: ζ Ursæ Majoris XIII.^{h} 20^m, N. 55° 25′, mags. 2, 4; separation, 14″·4.

ζ Aquarii XXII.^{h} 23^m, S. 0° 35′, mags. 4, 4, separation 3″·2. Both components are yellowish,

β Cygni XIX.^{h} 27^m, N. 27° 46′ mags. 3, 5; separation 34″. The brighter component is yellow, the other blue; very easy double in small telescopes with a power of 20.

Cluster (M 11) in Aquila or Antinous. R.A. 18^h 46^m; Dec. S. 6° 23′. Very pretty object for 3 or 4 inch telescope; it is an easily resolvable fan-shaped cluster, with an 8th magnitude star in apex and an open pair of the same magnitude just outside it.

(M 8) Cluster in Sagittarius; large luminous field of small stars; fine object in pair of field glasses. About a degree E. of the star 4 Sagittarii.

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CONTENTS—See page V.

An Interesting New Asteroid.

Approximation of the Mean Distance and Mass of TG.

By Prof. F. Tarrida del Marmol, C.E.

TG, the newly-discovered asteroid, is interesting, not only because it widens as far as the limits of the orbit of Jupiter the region of the small planets, but, too, as a confirmation—according to the results of recent observations—of the elegant theorem of Lagrange: "Three celestial bodies, whatever their masses, can move permanently at the angles of an equilateral triangle." Until now no confirmation was found in Nature of that curious dynamical possibility, the verification of which the great French mathematician left to future generations. Now, the Sun, Jupiter, and TG are precisely three bodies which, according to the observations alluded to above, verify the proposition of Lagrange.

The articles by Professor Abetti and by Mr. Crommelin which appeared in the August and September numbers of "Knowledge" respectively, strongly tend to confirm the above, as does the information published in the July issue; but I wish to remark, with reference to the latter, that there is surely an error in the observations quoted "of April 22nd combined with those of February 22nd and March 23rd, which show a mean distance a little *greater* than that of Jupiter." It is easy to prove that this mean distance is not larger, but rather smaller than that of the giant planet, and it is even possible to fix the limits of that distance and, consequently, obtain an approximation of the mass of TG. By the same process, that approximation will be substituted by an exact calculation when, through observation, the exact distance from the Sun of that asteroid will have been established.

Let d and d' be the respective distances of Jupiter and TG from the Sun, t the time of their revolution, which is identical for both according to observations, M the mass of the Sun, m that of Jupiter, and x that of the asteroid.

According to the Keplerian laws, taking the masses into account:—

$$\frac{d^3 \div t^2}{M + m} = \frac{d'^3 \div t^2}{M + x}$$

Whence

$$d^3 (M + x) = d'^3 (M + m)$$

Therefore

$$x = \frac{d'^3 M + d'^3 m - d^3 M}{d^3}$$

Or,

$$x = \frac{d'^3}{d^3}(M + m) - M \quad (A)$$

And again,

$$x = M\left(\frac{d'^3}{d^3} - 1\right) + m\,\frac{d'^3}{d^3} \quad (B)$$

The formula (B), since x, the mass of TG, is certainly smaller than m, that of Jupiter, shows that the quantity in parentheses must be negative, *i.e.*, that $\frac{d'^3}{d^3} < 1$,

or $d'^3 < d^3$

or $d' < d$.

—Q.E.D.

The formula (A) enables us to find limits between which the distance of TG to the Sun is to be fixed. We know that the mass of the asteroid must be greater than nothing and smaller, at least, than the hundredth part of that of Jupiter (or else it would have been seen long ago). We have then the two inequations:

$$\frac{d'^3}{d^3}(M + m) - M > 0 \quad (1)$$

$$\frac{d'^3}{d^3}(M + m) - M < \frac{m}{100} \quad (2)$$

M, m, and d being known, the solution of these inequations gives us the following limits (taking $d = 483{,}000{,}000$ miles):

$$d' > 482{,}855{,}100$$
$$d' < 482{,}879{,}250$$

which are both very near—but inferior—to the distance from Jupiter to the Sun.

As to the mass of TG, it will be possible to find it with all exactitude with the formula (A) when more precise observations will have established exactly the value of d'. Meanwhile, if we take a value comprised between the limits suggested above, rather nearer to the inferior one we find for the relation $\left(\frac{d'}{d}\right)$ the value 0·9990618.

The mass, then, of TG would be

$$x = \left(\frac{d'}{d}\right)(M + m) - M = 0{\cdot}9990618 \times 330310 - 330{,}000 = 0{\cdot}103158$$

a result which, in my opinion, shows nothing unlikely, although I am, for obvious reasons, inclined to believe that the calculation, when based on strictly exact *data*, will give a figure still smaller.

The Bioscope or Long-Focus Microscope.

By EMILE GUARINI.

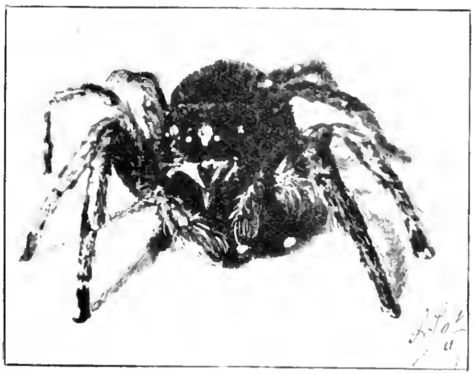
THIS apparatus has recently been devised by M. De Gasparis, of the University of Naples, and constructed by the Contaldi establishment of the same city; it was recently exhibited to the Regio Instituto at Incoraggiamento di Napoli. It is really a very long-focus microscope designed, as its name implies, for the study of the phenomena of animal life in all cases in which it is impossible for the observer to get close enough to the object that he is examining without running the risk of misinterpreting what he sees. It is, indeed, well known that the highly-improved and powerful microscope, to which modern science is indebted for most important discoveries, and the value of which is inestimable in certain domains, is becoming inadequate for the prosecution of some lines of study. It is capable of revealing the inmost structure of minute beings that escape our sight, and of counting the number of cells of which they are composed, but it is almost impossible to observe with it the phases of the normal life of such organisms. How, in fact, can we say that we observe the normal life of an organism when, in order to examine it, we are obliged to bring within a fraction of an inch of such an organism an apparatus that cannot fail to frighten it? In order to observe the normal life of microscopic organisms another instrument is, therefore, necessary, a long-focus microscope capable of being used in cases in which the ordinary instrument becomes inadequate. It is such an instrument that has recently been devised by M. De Gasparis. The apparatus, therefore, permits of obtaining the completest understanding possible of the normal life of insects, of the various manifestations of their intelligence, of their customs and habits, and of their relations with each other and the external world, and cannot fail to give the sciences of observation a new impulse. It has the advantage over the microscope of not necessitating a knowledge of a special technique, delicate and difficult to acquire. In this respect it puts scientific observation within reach of the amateur, who, as there are many examples to prove, is not to be despised. In the field of the bioscope the astonished eye of the observer perceives a new world, a series of scientific surprises. Hatred, anger, joy, and love are depicted in the acts of the infinitely small; the observer distinguishes their weapons and their wounds, and observes their palpitating viscera through their sides, and sees their minute bodies, in the last convulsions of the agony of death, trembling with a final spasm. The

The Bioscope in Use.

struggle for existence among these small organisms takes a character of almost human unsociableness. The smallest animals present themselves in the light of genuine monsters. Their rapid motions, evoked by no

How a Fly Looks in the Bioscope.

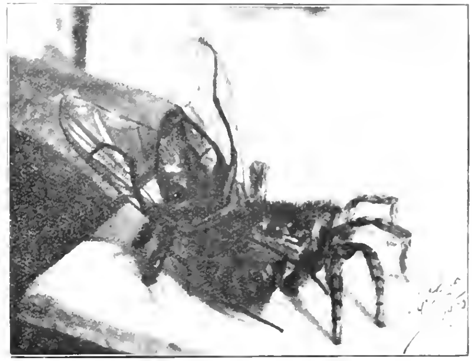
external cause, reveal their muscular power. The environment in which they live appears through the apparatus like a landscape with strange and fantastic forms, made attractive by multi-coloured plants of which the transparent structure carries our thoughts into other worlds or toward the remote epochs of the prehistoric ages of our planet. Ants furnish a particularly interesting field for observation, and spiders are no less curious objects for observation. The bioscope is also valuable for scrutinising the life of aquatic animals through the sides of an aquarium, or even in their natural element. It permits of studying bodies submitted to very high temperatures, electric discharges, &c. It may be added that in the domain of



A Spider at Work.

medicine it renders possible the observation, under a strong magnification, of dimly-lighted cavities (the larynx, ears, &c.), and of formulating a diagnosis in many cases that have up to the present been doubtful.

The apparatus is extremely simple, and is provided with a camera lucida to permit of the drawing of the objects observed. It consists of a tube with a rack provided internally with a system of achromatic objectives perfectly free from spherical aberration, and with



Spider Attacking the Fly.

a wide field eye-piece. The apparatus is also provided with a system of mensuration and various arrangements for supporting diaphragms. At a distance of 19.9 inches, the bioscope has a magnifying power of more than 12 diameters, say of 144 times the surface.

The Study of Heredity.

(Continued from page 531.)

The 253 hybrids thus obtained yielded, on self-fertilisation, 8,023 seeds, of which 6,022 were yellow and 2,001 green, the ratio being 3.01 to 1. Plants raised from the green seeds produced only green seeds in subsequent generations; that is, the "extracted recessives" are a pure race identical with the original recessive parental form. From a sample sowing of the yellow seeds Mendel raised 519 plants; of these 166 yielded exclusively yellow seeds, while 353 yielded yellow and green seeds in the proportion of 3 to 1. The former are pure dominants, and continued to breed true; the latter are hybrids of the same nature as those of the first filial generation, and it will be seen that the pure dominants are to the hybrid (apparent dominants) in the proportion of 1 to 2. The latter continue to split in subsequent generations in the proportions of 1 pure yellow : 2 hybrid yellow : 1 pure green; or 1 DD : 2 DR : 1 RR.

Mendel worked with considerable numbers of individuals, and, although in individual cases, when the numbers are small, the ratios may not be obtained so exactly as in the case cited, yet it is impossible to doubt the general accuracy of the ratios, when an average of the results is taken. The purity of the pure dominants and pure recessives resulting from the self-fertilisation of cross-breds was tested by Mendel in some cases as far as the 6th generation.

To explain these constantly recurring ratios, Mendel suggested that in peas each pure race produces egg

Table showing Mendel's results in the Cross between Peas with Yellow and Green Cotyledons respectively.

Cross.

Y♀ × G♂ or G♀ × Y♂

Seeds all yellow (YG)
Plants raised from these, and self-fertilised:
YG × YG

6022 Yellow seeds
Sample of 519 plants raised from these and self-fertilised showed

166 (YY) plants bearing only Yellow seeds — Breeds true

353 (YG) plants bearing both Yellow and Green seeds in the ratio
3 Y : 1 G
Of the 3 Y
1 (YY) Breeds true
2 (YG) continues to split — (1 G) Breeds true

2001 Green seeds
All Green — Breeds true

The same shown in general notation.

D = Dominant.
R = Recessive.

D × R or R × D

DR (all appear D)

DR × DR

3 appear D are made up of

1 DD : 2 DR : 1 RR
DD × DD DR × DR RR × RR

DD 1 DD 2 DR 1 RR RR

Breed true; pure Dominant — Hybrid splits as above — Breed true; pure Recessive

cells and pollen grains all of which carry the character proper to the race. When two opposite characters are brought together in hybridisation, they unite to form the hybrid character, which in the peas so closely resembles one of the parent characters as to be indistinguishable in appearance from it. The hybrid, in its turn, produces pollen grains and egg cells, which are either *pure dominant or pure recessive, and on the average, equal numbers of each kind are produced.* Each cross-bred is then producing gametes in the proportion of:—

♀ 50% pure Dominant.
50% pure Recessive.

♂ 50% pure Dominant.
50% pure Recessive.

In self-fertilisation, random mating between these male and female cells would give:—

$$25\,(D♀ \times D♂);\ 25\,(D♀ \times R♂);$$
$$25\,(R♀ \times D♂);\ 25\,(R♀ \times R♂);$$

D × R does not differ from R × D; we have therefore

$$25\,(D \times D);\ 50\,(D \times R);\ 25\,(R \times R).$$

And since cross-breds resemble dominants in appearance, the apparent result of the cross (DR × DR) is

3D : 1R.

Mendel next turned his attention to the crossing of races differing from one another in respect of more than one pair of characters. Suppose a race with round seeds and yellow cotyledons be crossed with one which has wrinkled seeds and green cotyledons. Mendel found the round and yellow characters to be dominant respectively over wrinkled and green. We therefore expect the first hybrid seeds to be all round and yellow, a result which Mendel actually obtained. The reproductive cells produced by these hybrids carry either the round *or* wrinkled, and either the yellow *or* green character, the possible combinations being:—

♀ RY ♀ RG ♀ WY ♀ WG
♂ RY ♂ RG ♂ WY ♂ WG

Mendel's hypothesis supposed that, on the average, equal numbers of these different kinds of reproductive cells (gametes) are produced. In self-fertilisation, therefore, random mating would give the following unions and their reciprocals, all occurring in equal numbers:—

♀ ♂	♀ ♂	♀ ♂	♀ ♂
RY : RY	RG : RG	WY : WY	WG : WG
RY : RG	RG : WG	WY : WG	
RY : WY	WG : RG	WG : WY	
RY : WG			
RG : RY			
RG : WY			
WY : RY			
WY : RG			
WG : RY			
9	3	3	1

In the first column are placed all those unions to which the dominant characters, round and yellow, are contributed at least by one of the parents; the plants resulting from these unions are, to the eye, indistinguishable from the pure dominants; in the second and third columns are placed those unions in which the dominant of one pair and the recessive of the other pair of characters is present; while the fourth column contains that union alone in which both pairs of characters are represented only by the recessive member. The offspring should, therefore, appear in the ratio of

9RY : 3RG : 3WY : 1WG.

a result to which Mendel's figures of

315RY : 108RG : 101WY : 32WG,

approximate so closely as to be well within the limits of experimental error.

The experimental results related above provide a simple illustration of the principles upon which the Mendelian theory of heredity is based. It would serve little purpose to recount here the numerous confirmatory experiments in the breeding both of animals and plants which have been carried out even in the short time which has elapsed since the rediscovery of Mendel's memoir.

Mendel specifically applied his hypothesis to explain the behaviour of certain characters in peas, without claiming to have discovered a universally applicable law. Widespread as the phenomena of dominance and segregation have since been found to be, it must not be supposed that they are universal. Already one or two cases are known in which a more complex form of segregation takes place, which seems to point to a *resolution* of compound characters introduced by the parents into a series of characters which, perhaps, may be susceptible of recombination, by means of suitable matings, into the original compound character.†

Nor does dominance occur universally. Speaking generally, the union of gametes bearing the different members of a pair of characters results in the formation of a hybrid whose character may be:—

(1) Indistinguishable from that of one of the parents.
(2) Intermediate between the characters of the parents.
(3) Unlike either of the characters of the parent.

The first result is that of simple dominance; in the second and third dominance is absent. When a hybrid of either of the last two types is self-fertilised, we are able to distinguish the offspring which result from the union of unlike gametes from the remainder, and thus the ratio of

1DD : 2DR : 1RR

among these offspring is at once appreciable (compare table p. 554). Finally, cases are known in which dominance is irregular, the offspring sometimes resembling one parent, sometimes the other. What determines the dominance in such cases is quite unknown, and it will be seen at once that the work is attended with great difficulty owing to the impossibility of recognising the constitution of any individual from its appearance.

In conclusion, attention must be drawn to the close parallel which exists, as Bateson pointed out in 1894, between the phenomenon of discontinuous variation and that of sex. There follows at once the question as to whether the sex-characters may not undergo segregation in the formation of the gametes of the male, or female, or both. A crucial experiment is still wanting, but indirect evidence is accumulating which steadily points toward an affirmative answer to the question.

It is not possible to go further into detail in this paper; enough has, I think, been said to indicate the principles of the Mendelian method. The offspring of each individual is treated separately, nor does one assume that any two individuals of like descent are similarly constituted until the analysis, carried out by the experiment of breeding from them, has proved them to be so. That is to say, it is not simply through a knowledge of the ancestry of an individual that we can certainly determine its nature, but by a knowledge of its posterity.

R.P.G.

* The production by the cross-bred of gametes pure in respect of one or other member of each pair of characters.

† Since the above was written it has been found that some, at any rate, of the cases referred to here are examples of a phenomenon of great interest. It is now clear that what appears to be a third distinct form may be due to the presence simultaneously of certain members of two definite allelomorphic pairs. For instance, in *Primula sinensis* a strain is known which is characterised by the extensive spreading of the central yellow eye. All these "yellow flush" plants are in the condition called by Darwin "equal-styled." Experiment shows that the yellow flush is an ordinary recessive character, the common non-flushed type being dominant. The flush is transmitted independently of the length of style, and may be transferred to the short-styled or thrum type. Yet when the flush is developed in plants which by gametic composition would be long-styled, the style does not pass through the anthers, and the equal-styled form is produced.

The International Conference on Hybridization and Plant-breeding.

The organisers of the third International Conference on Hybridization, held at Westminster under the auspices of the Royal Horticultural Society, must be heartily congratulated on the great success which attended the meeting. It was a fortunate circumstance that so many distinguished foreign guests were able to accept the Society's invitation, so that the scientific and practical workers of this country had the pleasure of welcoming representatives from Denmark, Germany, Austria, and France, as well as from the United States and Canada.

Since the first Conference was held at Chiswick in 1898, almost revolutionary advances have been made in the study of heredity and variation. It is difficult to realise that only six years ago Mendel's work was still buried in the obscurity where it had lain for 35 years. The scarcely less important discoveries of de Vries, on the origin of species by Mutation, are of still more recent date. No better instances can be cited than those of the successful unravelling of problems in heredity and variation by means of the exhaustive study of a special case. In this method lies the key to the progress which has been made, and to the solution of further problems in the future.

In opening the proceedings of the Conference the President, Mr. Bateson, contrasted the present state of our knowledge of heredity with that which obtained at the first Conference eight years ago. At that time the predominant note was mystery; now we speak less of mystery and more of order; systematic research has now replaced work that could only be carried on in the dark, along ill-defined lines. Mr. Bateson proceeded briefly to discuss some of the practical and theoretical results of the Mendelian laws. He showed that we have now a clear conception of the meaning of "pure-bred," a pure-bred individual being one which develops from the union of two cells, male and female, which are alike in composition, in that they bear identical characters. In the same way Reversion may be explained as the meeting once more of characters long separated, and, conversely, Variation is often the visible sign of separation, or segregation into different germ cells, and thence into different individuals, of characters which have hitherto been known only in combination with one another. The discoveries of Mendel have made it possible to subject the work of the hybridist to precise investigation, and often suggest the course which should be pursued in the attempt to create and fix desirable types, a course which is not always, by any means, that which unaided common sense might suggest. The great advances in the application of science to practical use have generally become possible through discoveries made in the pursuit of knowledge as an end in itself, without ulterior purpose, and it is to work carried on in this spirit that we should look for future results.

Of the numerous papers which were read before the Conference, one of the most interesting was that in which Miss Saunders described her experiments upon Stocks (Matthiola). The flower-colour in Stocks, as in Sweet Peas, has been found to depend upon the simultaneous presence in one individual of two elements belonging to independent allelomorphic pairs. If the reader will turn to page 550 of the current number he will see that, representing the presence of these elements by the letters A and B, and their absence by a and b, out of 16 individuals there will be on the average nine possessing both factors, and seven having only one or neither of them. That is to say, the ratio of coloured to white-flowered offspring will be as 9 : 7. The coloured plants, moreover, are found to consist of two main classes, purples and red, which occur in the ratio of 3 : 1, thus demonstrating the existence of a third allelomorphic pair, the presence or absence of a blue factor, which, however, can only produce a perceptible effect when the characters A and B are also present. In the 10-week Stocks the problem is further complicated by the fact that the hoariness of the leaves is found similarly to depend upon the presence of two independent factors; not only so, but, in general, this hoariness is only produced if the colour factors also be present! This discovery of the fact that two, and possibly more, independent allelomorphic pairs may enter into the composition of an apparently simple character, is of far-reaching importance in affording an explanation of many results which have hitherto appeared quite irregular and even contradictory.

Mr. Biffen gave an account of some experiments upon breeding of wheat, which must lead to results of supreme practical, as well as theoretical, value. The loss which is entailed every year to wheat crops through the attacks of rust is only too well known. Occasionally, however, there are found plants which show themselves to be immune from the attacks of the fungus. Mr. Biffen has shown beyond any question that this immunity is a transmissible character, inherited according to simple Mendelian principles. The raising of crops immune from rust should, therefore, be only a matter of time. It is not necessary to dwell on the immediate practical value to agriculture of this result; further, it opens a wide field for experiment as to the inheritance of physiological (as distinct from morphological) characters in general, and gives hope of the possibility of producing, by appropriate breeding, in other plants and animals strains immune from certain diseases.

Dr. Rosenberg, of Stockholm, furnished a most interesting paper upon the behaviour of the chromosomes in the formation of the germ cells in hybrid plants. Although much yet remains to be done, and our present evidence is largely indirect, we may look forward confidently to the day when cytological work will give us the key to what we may call the mechanism by which segregation of characters in the germ cells is brought about.

Want of space compels us to omit all mention of many other contributions both of scientific and of practical value, of which full reports will be published in the Royal Horticultural Society's Journal. The heartiest thanks of those who had the privilege of attending the Conference are due to the Royal Horticultural Society and to its members for the generous hospitality which was provided for all. One cannot appreciate too highly the opportunity which the Conference has afforded of meeting those who are working in other countries; of equal value, too, is the recognition given at the Conference to the importance of combined effort between scientific investigators and practical horticulturists; each can provide just that knowledge which is apt to be lacking in the other, and so assist the advance along their respective paths.

Stellar Distances.

By T. E. HEATH, F.R.A.S.

THE list of stars here given, with their magnitudes, spectra, distances in light-years, hypothetical diameters in miles, and sun-power, is taken from my last work, "Stereoscopic Star Charts and Spectroscopic Key Maps," in which the authorities are given. I have added four stars collected from measurements by Prof Pritchard. As my object was to show all the stars to the fifth magnitude in space of three dimensions, and as I had to use estimated average distances according to magnitude and spectrum for the stars for which I could obtain no measured parallax, I naturally collected all I could. If I believed the distances to be very good, I marked them **, good *, very doubtful ?. I have here grouped the stars according to magnitude and worked out the average distance and sun-power for each magnitude, although beyond magnitude 1·5 the parallaxes measured are too few to make the averages useful. Naturally the nearest stars only have been measured where the magnitudes are small. The hypothetical diameters in miles are calculated upon the supposition that the sun and stars, for equal surfaces, give equal light, and, though this is certainly not true, form a foundation upon which we can build ideas as to size which will be greatly modified by the spectra and temperature of the stars as compared with the sun. I have assumed the sun's magnitude is −26·5. Readers of my first article in "KNOWLEDGE" will recollect my scale for stellar distances. If the distance of the earth from the sun be represented by one inch, then one light-year will be represented by one mile, and the distance to the furthest known planet by one pace of 30 inches. So to journey mentally to Sirius you think of walking 8⅔ miles with strides sufficient at each pace to carry you to Neptune.

I give the mass in a few cases. It is evident in some cases, as the bright star of Sirius and Algol, the density is far less than the sun's; but with the darker star of Sirius and of 85 Pegasi, it is much greater.

MAGNITUDE −1·58 TO −0 50.

R. A. H. M.	Decl. ° '		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.	Mass.
6 21.7	− 52 38	α Carinæ .	−0·86	F	? 543	219,000,000	63,756	0
6 40.7	− 16 35	α Canis Major s	−1·58	A	** 8·64	4,980,000	32·72	3 5
		2 Stars average .. .			275·8		31,894	

MAGNITUDE −0·49 TO − 0·50.

R. A. H. M.	Decl. ° '		Mag.	Spect.	Light Years.	Hyp. Dia	Sun Power.	Mass.
5 9.3	+ 45 54	α Aurigæ	+ 0·21	G	** 37·4	9,450,000	117	18 4
5 9.7	− 8 19	β Orion s	− 0·34	B8A	? 543	128,600,000	21,609	
5 49.8	+ 7 23	α Orionis	− 0·31 0·94	Ma	112	26,770,000	952	
7 34.1	+ 5 29	α Canis Minoris	+ 0·48	F5G	** 9·55	2,123,000	6	3·63
14 11 1	+ 19 42	α Bootes ..	− 0·24	K	*95·8	23,740,000	827	
14 32.8	− 60 25	α Centauri	− 0·36 − 1·67	G K5M	** 4·30	1 013,800 554,000	1·37 0·40	2·0
18 33.6	+ 38 41	α Lyræ .	+ 0 14	A	**36 6	9,445,000	119	
		7 Stars average ..			119·8		3351	

MAGNITUDE 0·51 TO 1·50.

R. A. H. M.	Decl. ° '		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun." Power.
1 31.0	− 57 45	α Eridani	0·60	B5A	69·3	14,700,000	289
4 30.2	+ 16 14	α Tauri	1·06	K5M	** 28·1	4,680,000	29·2
7 39.2	+ 28 16	β Geminorum	1·21	K	* 49·3	7,620,000	77
10 3.0	+ 12 27	α Leonis	1·34	B8A	* 105	15,600,000	324
12 21.0	62 33	α Crucis .	1·05	B1A	66·3	11,260,000	169
12 41.9	59 9	β Crucis	1·50	B1A	? 362	49,500,000	3271
13 19.9	− 10 38	α Virginis	1·21	B2A	? 217	33,620,000	1505
13 56.8	− 59 33	β Centauri	0·86	B1A	* 90·5	16,670,000	370
16 23.3	− 26 13	α Scorpii	1·22	MA	* 121	18,700,000	467
19 45.9	+ 8 35	α Aquilæ	0·89	A5F	** 13·6	2,470,000	8·12
20 38.0	+ 44 55	α Cygni	1·33	A2F	?? 465	68,460,000	6241
22 52.1	− 30 9	α Piscis Aust. .	1·29	A2F	** 249	3,750,000	18·7
		12 Stars average .. .			124 6		1064

MAGNITUDE 1·51 TO 2·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.	Mass.
0 3.2	+ 28 32	α Andromedæ	2·15	A	55·2	5,630,000	42	
0 3.8	+ 58 36	β Cassiopeiæ . .	2·42	F5G	** 32·6	3,000,000	11·5	
0 34.8	+ 55 59	α Cassiopeiæ . .	2·47	K	99·5	8,030,000	87	
0 50.7	+ 60 11	γ Cassiopeiæ . .	2·25	B	? 460·0	45,200,000	2725	
1 4.1	+ 35 5	β Andromedæ	2·37	Ma	35·4	3,260,000	14·2	
1 22.6	+ 88 46	α Ursæ Minoris	2·12	F8G	44	4,530,000	27·5	
2 1.5	+ 22 59	α Arietis . .	2·23	K2M	40·7	4,000,000	21·3	
3 1.0	+ 40 34	β Persei .	2·31	B8A	93	8,750,000	102	0·67
3 17.2	+ 49 30	α Persei . .	1·90	F5G	44	5,110,000	35	
5 20.0	+ 28 31	β Tauri . .	1·78	B8A	51·7	6,200,000	51	
5 52.2	+ 44 56	β Aurigæ . .	2·07	A Pec	54·3	5,630,000	42	
7 28.2	+ 32 6	α Geminorum	1·58	A	? 16·4	2,160,000	6·25	
10 14.5	+ 20 21	γ Leonis . .	2·30	K	165	13,900,000	259	
10 58.8	+ 56 55	β Ursæ Majoris	2·44	A	197	17,300,000	400	
10 57.6	+ 62 17	α Ursæ Majoris	1·95	K	70·7	7,80,0000	81	
11 44.0	+ 15	β Leonis . .	2·23	A2F	112	11,000,000	162	
12 49.6	+ 56 30	ε Ursæ Majoris	1·68	A	197	24,740,000	815	
13 19.9	+ 55 27	ζ Ursæ Majoris	2·09	A	197	20,530,000	562	
13 43.6	+ 49 49	η Ursæ Majoris	1·91	B3A	? 24·3	3,900,000	20·25	
14 51.0	+ 74 34	β Ursæ Minoris	2·24	K5M	148	14,700,000	189	
17 54.3	+ 51 30	γ Draconis . .	2·42	K5M	65·2	5,640,000	43	
20 18.6	+ 39 56	γ Cygni	2·32	F8G	31·9	3,030,000	12·3	
22 1.9	− 47 27	α Gruis . .	2·16	B5A	** 148	15,079,000	303	
		23 Stars average . .		. .	101·8		268	

MAGNITUDE 2·51 TO 3·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.	Mass.
0 20.5	− 77 49	β Hydri . .	2·90	G	** 22·5	1,610,000	3·45	
8 52.5	+ 48 26	ι Ursæ Majoris	3·12	A5F	25	1,655,000	3·6	
9 26.2	+ 58 2	θ Ursæ Majoris	3·26	F8G	70·9	4,330,000	25	
11 48.6	+ 54 15	γ Ursæ Majoris	2·54	A	** 197	16,700,000	372	
12 10.5	+ 57 35	δ Ursæ Majoris	3·44	A2F	197	11,000,000	161	
12 36.6	− 0 54	γ Virginis	2·91	F	** 44	3,155,000	13·25	3·3
16 37.5	+ 31 47	ζ Herculis . .	3·00	G	23·3	1,550,000	3·21	
17 10.1	+ 14 30	α Herculis . .	3·1 3·9	Mb	65·2	4,330,000	25	
17 10.9	+ 24 57	δ Herculis . .	3·16	A	65·2	4,330,000	25	
17 11.6	+ 36 55	π Herculis	3·36	K2M	29·6	1,730,000	4	
20 42.2	+ 33 36	ε Cygni	2·64	K	28·3	2,250,000	6·76	
21 39·3	+ 9 25	ε Pegasi	2·54	K	40·7	3,520,000	16·7	
21 16.2	+ 62 10	α Cephei .	2·60	A2F	53·4	4,640,000	25·8	
22 59.8	+ 14 40	α Pegasi .	2·57	A	40·2	3,470,000	16	
		14 Stars average . .		. .	64·4		50	

MAGNITUDE 3·51 TO 4·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.	Mass.
0 14.9	− 65 28	ζ Toucanæ . .	4·34	F8G	** 20	730,000	0·70	
0 43.0	+ 57 17	η Cassiopeiæ . .	3·64	F8G	** 21·1	1,080,000	1·56	1·62
1 39.4	− 16 28	τ Ceti	3·65	G	* 11	567,000	0·42	
3 15.9	− 43 27	e Eridani	4·30	G5K	20·3	762,000	0·79	
3 28.2	− 9 48	ε Eridani . .	3·81	K	?? 17·7	832,000	0·92	
4 10.7	− 7 48	O² Eridani . .	4·48	H	** 15·8	537,000	0·39	
6 9.0	+ 44 56	κ Aurigæ . .	4·45	K	65·2	2,250,000	6·76	
7 55.4	− 48 58	V Puppis	4·1 4·8	Pec B1A	1810·	74,400,0000	7361·	
8 54.2	+ 42 11	10 Ur. Majoris . .	4·09	F5G	* 16·3	676,000	0·61	
13 7.2	+ 28 23	β Comæ Ber. . .	4·32	G	29·3	1,090,000	1·59	
13 21.2	+ 55 30	g Ursæ Majoris	4·02	A2F	197	7,800,000	81·	
14 1.7	+ 64 51	α Draconis . .	3·64	A	13	667,000	0·58	
16 39.5	+ 39 7	η Hercules . .	3·61	K	8·11	1·3,000	0·.5	
18 0.4	+ 2 31	70 Ophiuchi . .	4·07	K	** 20·1	830,000	0·92	2·9
18 4.5	+ 86 37	δ Ursæ Minoris . .	4·44	A	108·6	3,720,000	18·5	
18 41.4	+ 20 27	110 Hercules . .	4·26	F	81·4	3,030,000	12·2	
21 40.1	+ 25 11	κ Pegasi	4·27	F5G	30·7	1,157,000	1·57	
		17 Stars average		. .	146		440	

MAGNITUDE 4·51 TO 5·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.	Mass.
1 1.2	+ 54 27	μ Cassiopeiæ . .	5·34	H	29·6	698,000	0·64	
4 1.9	+ 37 47	50 Persei . .	5·5		81·4	1,780,000	4·25	
6 39.5	+ 43 51	ψ ⁵Aurigæ . .	5·3		29·6	745,000	0·71	
6 53.7	+ 87 12	51 H Cephei	5·2		120·7	3,010,000	12·3	
7 41.9	− 33 59	Lac 2957 . .	5·42		** 33·9	770,000	0·79	
9 55.2	+ 32 25	20 Leo Min. . .	5·5		54·3	1,190,000	1·88	
17 30.2	+ 55 14	ν ¹Draconis . .	4·98	A	* 10·1	277,000	0·102	
19 20.2	+ 11 44	31 Aquilæ . .	5·3		47·9	1,110,000	1·57	
19 32.6	+ 69 29	σ Draconis	4·78	K	12·4	372,600	0·185	
21 21	+ 38 17	61 Cygni . .	4·96	H	** 10·0	268,000	0·102	
21 9.6	+ 9 36	δ Equulei	4·61	F	** 15·7	1,480,000	2·92	1·89
21 55.7	− 57 12	ε Indi	4·74	K5M	** 11·1	316,000	0·16	
		12 Stars average . .		. .	10·56		2·136	

MAGNITUDE 5·51 TO 6·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.	Mass.
11 29.6	− 32 18	Brad 1581	6·0		108·6	1,870,000	4·67	
11 33.5	+ 45 40	Σ 1561 . .	6·3		108·6	1,600,000	3·42	
11 47.2	+ 38 26	Gr 1830 . .	6·47		*** 21·7	303,000	0·122	
12 10.0	− 9 43	Ll 22954 .	6·05	E	* 23·3	400,000	0·267	
14 51.6	− 20 57	P XIV hr 212	6·08	H	** 19·0	312,000	0·11	
20 56.6	+ 39 51	Gr 3357	6·00		16·5	781,000	0·81	
23 8.5	+ 56 37	Brad 3077 . .	5·6		21·7	459,000	0·27	
23 57	+ 26 33	85 Pegasi .	5·83	E	60·3	1,135,000	1·72	11·3
		8 Stars average			51·2		1·416	

MAGNITUDE 6·51 TO 7·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.
9 7.7	− 53 7	Ll 18115	7·5	H	24·3	200,000	0·154
10 5.3	+ 48 58	Gr 1618 or CA [illegible]	6·75	H	18·4	225,000	0·067
10 21.9	+ 49 21	Gr 1616 . .	6·54	A	29·6	400,000	0·213
11 8.6	+ 71 4	Σ 1516	7·0		30·4	346,000	0·160
11 8.6	+ 71 4	Fed 1831	7·2		14·8	147,000	0·029
12 1.6	11 51	Ll 22810	7·5		48·5	420,000	0·225
12 4.6	+ 46 4	Gr 1835 . .	7·4		54·3	500,000	0·325
22 59.4	36 36	Lac 9352	7·4		10·8	112,260	0·071
		8 Stars average . .		. .	28·7		0·137

MAGNITUDE 7·51 TO 8·50.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.
0 12.7	+ 43 27	Gr. 34	7·9		10·6	75,000	0·008
5 7.7	− 45 3	CZ Vh 243	8·5		** 10·2	53,700	0·004
7 47.2	+ 30 52	Ll 15290	8·2		163·0	1,630,000	1·440
9 7.0	+ 53 7	Fed 1457	8·0 8·0		14·1 15·1	97,000 104,000	0·0125 0·0141
9 37.1	+ 43 10	Ll 19022	8·0		51·3	340,000	0·157
10 27.7	+ 49 12	Gr 1657	7·6		67·8	564,000	0·400
10 38.0	+ 47 7	Ll 20671	7·9		326·0	2,240,000	7·300
10 57.9	+ 56 38	Ll 21185	7·6		9·8	78,000	0·008
11 0.5	+ 44 2	Ll 21258	8·5		** 13·6	72,000	0·007
11 40.3	+ 48 14	Gr 1822	7·7		163·0	1,300,000	2·200
14 52.3	+ 54 4	Fed 2541 or Ll 27298	7·7		37·0	290,000	0·110
18 4.1	+ 59 27	Σ 2298	8·2		9·2	60,000	0·005
		13 Stars average . .		. .	68·7		0·9026

MAGNITUDE 8·51 TO 11.

R. A. H. M.	Decl. ° ′		Mag.	Spect.	Light Years.	Hyp. Dia.	Sun Power.
11 14.8	+ 66 22	OA 11677	9·0		12·0	52,000	0·0040
17 37.0	+ 68 26	OA 17417	9·0		13·0	59,000	0·0046
18 41.7	+ 59 29	Σ 2398	8·5 9·3		10·93 11·30	60,000 21,600	0·0050 0·0025
22 24.0	+ 57 10	Krueger 60	9·0 11·0		12·0 12·0	31,000 5,200	0·0036 0·0008
		6 Stars average . .			11·87		0·0034

Summary

Mag.			Light Years	Sun Power.
Mag. − 1·58 to Mag. − 0·50	2 stars	average	275·8	31,894
,, − 0·49 ,, ,, + 0·50	7 ,,	,,	119·8	3,861
,, + 0·51 ,, ,, + 1·50	12 ,,	,,	134·6	1,064
,, + 1·51 ,, ,, + 2·50	23 ,,	,,	101·8	268
,, + 2·51 ,, ,, + 3·50	14 ,,	,,	64·4	50
,, + 3·51 ,, ,, + 4·50	17 ,,	,,	146·6	140
,, + 4·51 ,, ,, + 5·50	12 ,,	,,	40·5	2·136
,, + 5·51 ,, ,, + 6·50	8 ,,	,,	51·2	1·416
,, + 6·51 ,, ,, + 7·50	8 ,,	,,	28·7	0·137
,, + 7·51 ,, ,, + 8·50	13 ,,	,,	68·7	0·902
,, + 8·51 ,, ,, + 11·0	6 ,,	,,	11·0	0·0034
123 Stars				

Answers to Correspondents.

An Old Subscriber. We propose very shortly to continue the series of Star Maps, but we have been having considerable trouble in getting a really satisfactory means of reproducing them. The De Forest system of Wireless Telegraphy was described in "THE ILLUSTRATED SCIENTIFIC NEWS" for July, 1903. It differs from the Marconi in the sending apparatus, in which no interrupters or coils are employed but an ordinary alternating current, and in the receiving apparatus which is dependent on an electrolytic principle for its action.

Reading. The primitive barometer described, namely a long-necked flask inverted in a jar of water, is an instrument with which we cannot claim any experience. Theoretically, however, it should act on the same principle as an ordinary mercury barometer, that is, when the pressure of the atmosphere increases, the water should be pressed up the neck of the bottle. But with such an apparatus many other factors have to be considered, one of the chief being the temperature, both of the outside air and the air and water contained in the bottle. The evaporation of the water must also be taken into account.

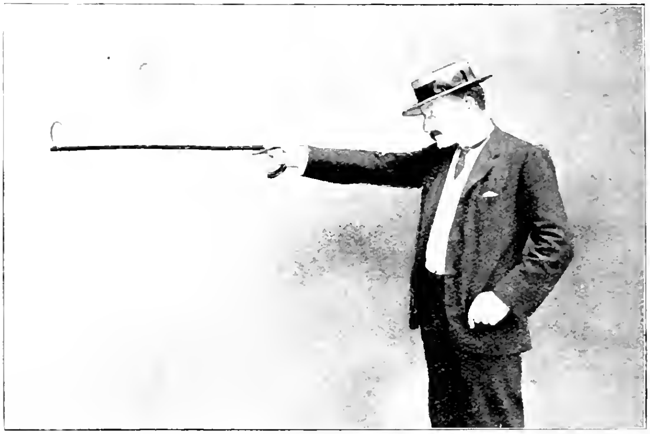
C.E.C. The Harvest Moon is the name popularly given to the full moon in September. At this period the moon rises for several evenings running at about the same hour, because its gradual northward movement compensates for its retardation in rising. This is supposed to favour the gathering of the harvest.

T.G. Amber containing insects is often to be bought from naturalists or from tobacconists (who keep it as a curiosity). But it seems that it is not regularly supplied by either, being so seldom in demand. Tanks for aquaria are to be obtained from Messrs. Watkins and Doncaster, 36, Strand, W.C.

The "Unilens," A Simple Telescope.

It is curious how, occasionally, some very simple application of known principles is brought forward as a practical appliance, which, for some reason, has never before been tried, or, rather, widely applied, to the purpose. This is the case with the "Unilens," lately patented by Major Baden-Powell. It consists merely of a convex lens, $2\frac{1}{2}$ inches diameter, having a focal length of about 6 feet. This, mounted temporarily at the end of a stick, enables an enlarged view of distant objects to be obtained, the maximum magnification being about 4 diameters. Considering the extreme simplicity and low cost of the appliance, it should form a most handy glass for all ordinary purposes, comparing favourably as regards power with the cheaper opera and field glasses. As now designed, the glass is mounted on a metal base from which projects a small screw, and it may thus be readily affixed to any walking-stick, &c., while, being so small and flat, it can be carried in the waistcoat pocket.

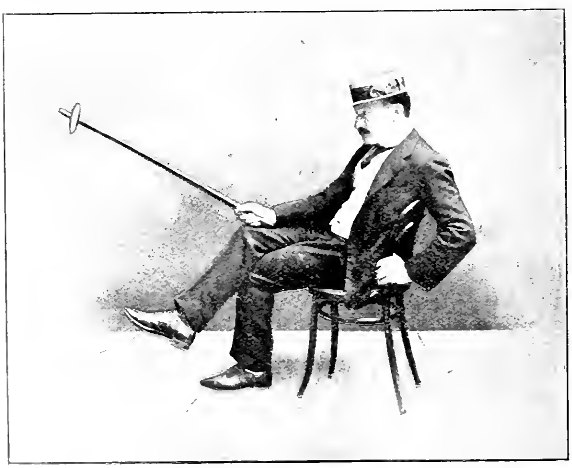
Though there may be no special novelty in this appliance as an optical instrument, yet as a practical means of observation it should prove of great value to almost all observers of Nature. As an astronomical instrument it can, of course, hardly claim a high place, yet so simple and portable an apparatus has its uses. We know how useful even a low-power opera-glass can be in looking on the heavens, and many features are thus clearly shown which are not perceptible to the naked eye. For instance, on looking at the Pleiades through the "Unilens" eight stars can be discerned, although it is seldom that more than six are visible to the unaided vision. The naturalist will certainly find this portable glass of great assistance in watching birds and beasts even at a few yards off, at which distance they are greatly magnified. The botanist, too, may find it of use in examining plants out of reach.



"Unilens" at Full Focus.

This glass has the great advantage of always being in focus. The further it is held from the eye the greater is the magnification. But it it be merely held in the hand at arm's length it is a great aid to natural sight, and is most useful in the theatre or even picture gallery or cathedral. When on the end of a stick, and the stick held at arm's length, that is to say, when the glass is approaching six feet from the eye, objects are seen at the greatest magnification, although they then begin to get slightly blurred.

It need hardly be said that such a glass is not suitable to all eye-sights. Those slightly affected by myopia, or short-sight, do not see well through the single lens. But if these persons use a concave eye-glass as well, not only will they see clearly through the "Unilens," but will improve their sight under ordinary circumstances by the habitual use of the eye-glass. This little appliance is being placed on the market by Messrs. Newton, of Fleet Street.



An Easy Position.

Nature-Study : A Field Lesson at Werribee Gorge, Bacchus Marsh. (Melbourne: Government Press, 1906). This well illustrated account of a visit of pupils to the locality mentioned is published as a supplement to the Melbourne *Education and Teachers' Aid*, and shows that the Victorian Government is thoroughly awake to the necessity of going to the original source, if education in natural science is to be of any value. The members of the party were fortunate in having presented to them some excellent specimens of ancient glaciation.

Pendulums Used in Gravitation Research.*

By W. H. Sharp.

The laws of falling or moving bodies were investigated in ages long before Galileo's time (about 1600), and probably with much greater success than is at present commonly supposed. His experiments with bodies falling from the top of the Tower of Pisa were connected with the opening of a new chapter in gravitation research.

Newton, in 1710, made similar experiments in London with bodies falling freely directly downwards to the earth from a great height, and based his celebrated theory of gravitation upon the results attained thereby, and by means of his own famous experiments with vertical pendulums, eleven feet long, suspended from the ceiling of a room.

Two centuries ago the pendulum had become recognised as specially suitable for gravitation research, because it was possible by its means to substitute the gliding motion of a pendulum bob in a smooth curved path or long arc of a circle, for its fall down a short straight path representing the versed sine of that arc, or in other words the vertical depth from top to bottom of that smooth curved path.

Pendulums—and I must be understood to refer particularly to such as are used for astronomical purposes—may be regarded as belonging to one or other of three classes, according as the plane in which they are designed to oscillate is:—(A) Vertical, (B) Horizontal, or (C) Inclined, with reference to the horizon at the place where they are used.

When the pendulum is constructed by hanging a weight at the lower end of a cord, wire, fibre, or other material from one point above, so that the weight may oscillate to and fro, its suspension is said to be unifilar. Newton's was of this kind (see Fig. 1). But, if by hanging a weight by two equal cords, wires, or other materials, from two points above, its suspension is said to be bifilar (see Fig. 3). The unifilar vertical pendulum is like an ordinary plumb-line, and one great objection to it is, that being free to move not only to and fro, but also sideways, it does not continue oscillating in one direction—in one plane—to and fro, but tends to change its direction all the time it continues swinging.

The bifilar suspension imposes a limit upon that tendency to change, and tends to leave the pendulum free to oscillate to and fro in one plane only.

Gauss and Weber used a bifilar suspension, and also the well-known mirror reflecting a ray of light, about 1836, in their pendulum experiments.

(A) *Vertical pendulums*, or plumb-lines have been used in four different ways in gravitation research.

(1) To compare forces acting upon them, by counting the number of oscillations produced in equal times under similar conditions by different forces (Fig. 1).

(2) To compare forces acting laterally upon them, when hung as plumb-lines at rest, for instance near the side of a mountain, by measuring the distances through which they were drawn out of the vertical. Bouguer (1738) and Maskelyn (1772) used that method, with long plumb-lines near mountain sides, and Gruithuisen (1817) used a ten-foot thread pendulum—his "elkysmometer"—to indicate variations of lunar attraction (Fig. 1).

(3) To demonstrate the rotation of the earth by measuring the rate of angular deviation of the plane of oscillation of a unifilar pendulum. This was done by Foucault in 1851, who proved that the rate of deviation depends upon the latitude of the place in which the experiment is made (see Fig. 2).

(4) To measure, if possible, the "Lunar variation of gravity" by using a vertical bifilar suspended pendulum, as suggested by Lord Kelvin in 1878, with a Gauss mirror attachment, and as used by or for the British Association Committee in the abortive experiments reported for them by G. H. Darwin, in 1881. (*Vide* British Association Reports, 1881-2.)

Among other notable experiments on gravitation by means of vertical pendulums are those of Du Buat (1786), Carlini (at Mont Cenis), Bessel (1826), Horsford's† with a 220 feet pendulum in a tower, and Airy's in a coal mine 1260 feet deep.

In every instance where a vertical pendulum has been used for gravitation research, a weight has had to be lifted against the vertical downward force of the earth's gravitation, and in order to avoid the necessity of so doing, the vertical pendulum was abandoned about the end of the eighteenth century by leading men in the scientific world, who adopted the horizontal pendulum as a more promising instrument of research.

(B) *Horizontal pendulums*—most properly so termed—consist of a rod having a ball at each end, and supported horizontally, after the manner of an ordinary compass needle, upon a point at the middle of the rod. The earth's downward pull upon the ball at one end is exactly balanced by its downward pull upon the ball at the other end of the rod, and there is therefore no need in practice to consider the vertical downward force of gravity so far as such a pendulum is concerned. There is also no reason why such a pendulum under ordinary conditions should tend to rest in any one particular horizontal direction rather than in any other. In fact it is not known as having any definite directive tendency.

It is an immense advantage to be able to work upon delicate gravitation research without interference by the earth's downward attraction, but immediately one begins to avail of that advantage, the need of a definite directive tendency is obvious. A magnetic needle has a tendency to set in one definite direction, and we may use various means to cause it to depart therefrom, and measure the angles or distances through which it is moved thereby, for the purpose of comparing the forces involved. So also the plumb-line or vertical pendulum had a definite directive tendency to adopt the nearest position to the earth's centre, and in a straight line directed thereto.

Coulomb overcame this difficulty by suspending the horizontal rod with the balls at its ends as aforesaid—by attaching a wire at the middle (or centre of gravity) of the rod and fastening the other end of the wire to a point above. This was instead of using a pointed support, as in the mariner's compass, and with such a wire suspension the rod always had a definite tendency to take up and maintain a certain direction which was determined by the molecular arrangement of the particles of the wire suspension, etc. (see Fig. 4).

He called his horizontal pendulum, so suspended, a torsion balance, and the horizontal pendulums after

* All Rights Reserved.

† *Vide* Proc. Am. Assoc. for Advancement of Science, 1852.

wards used by Cavendish (1798), by Reich (1836), and by Baily (1842) in their famous gravitation experiments were nothing more nor less than torsion balances, even though bifilar silk fibre suspensions were in some cases used instead of a single wire suspension to give definite directive tendency to the pendulum rod, by limiting its freedom (see Fig. 5).

The advantage of definite directive tendency gained by suspension, whether unifilar or bifilar, and whether by cord, wire, fibre or other material, was only gained at the cost of restoring in some degree the disadvantage of having to lift to a very slight extent against earth's vertical downward attraction the weight of the pendulum rod with its two balls. For torsion implies twisting, and consequent shortening or lengthening of the suspension, and raising or lowering of the rod, etc. And granting that in alternate excursions of oscillation, about a mean direction line of rest, the raising and lowering involved might be equal and opposite in amount, and neutralise each other, yet the fact would remain that the path of each ball would tend to have a slightly spiral form, and not be strictly horizontal.

With those horizontal pendulums pairs of large attracting masses were used, and these were so placed near the pendulum balls that their attractive forces were exerted at the same time, so as to produce a combined rotational effect in the same direction in the approximately horizontal plane. That rotational effect, or lateral pull, with reference to the definite direction line, or mean line of rest, was calculated from the number of oscillations, the weights and distances of the attracting masses involved, and the times, by using Coulomb's formula, etc.

A very full account of the latest of those experiments, and reference to others made previously, will be found in Vol. 14 of the "Memoirs of the Royal Astronomical Society, 1843." In all cases of such experiments on gravitation, with horizontal pendulums, "anomalies" of attraction were noticed, resulting in a "march" of scale readings, or "reversals" of direction, etc., for which the observers were unable to account. Such anomalies were discussed by Poisson (1834), Plana, John Herschel, Herne, and others mathematically and otherwise. Grant's "History of Physical Astronomy" may be consulted for further reference thereon.

(C) *Inclined pendulums.*—These are wrongly called horizontal pendulums usually, and apparently for no better reason than that the rod used is sometimes approximately horizontal, and is intended to be used in the investigation of force exerted in a horizontal plane. But they do not oscillate in a horizontal plane, they are not as a rule even intended or designed to do so. Implicitly or expressly, others are designed so that they are not horizontal, and can only be properly used in inclined planes.

The absurdity of classing these pendulums with those of the class which contains Coulomb's and Cavendish's pendulums will best be appreciated by observing the essential distinction which exists between them. The Coulomb and Cavendish class, in addition to the characteristics already noticed, involves two weights on one rod, and the earth's downward attraction upon one of those weights is balanced by the similar attraction upon the other, as at the opposite end of a lever having its fulcrum in the middle or where the suspension line is attached, and where the centre of oscillation is supposed to remain constant in position, but in practice cannot and does not do so. Whereas the inclined pendulums have a weight only on one end of a rod, and in consequence of having no counterbalancing weight at the other end to neutralise the earth's attraction upon it, various different devices have been used to effect that neutralisation otherwise than by using a second weight, and subject to the retention of a very minute unneutralised fraction of its own weight merely for the sake of imparting definite directive tendency by inclining the pendulum specially for that purpose. Moreover, while those in the former class never have a constant centre of oscillation, those in the inclined class may have, and in some instances practically have.

Hengler's Pendulum (1832), appears to be the first inclined astronomical pendulum known in modern times. His account of same I found this year (1906) in *Dingler's Polytechnisches Journal*, 1832, printed in the old German characters. I know of no translation ever having been published in the English language, and have had to make a translation specially for my own satisfaction.

His rod was suspended by a short cord or wire from a point in the ceiling and so that the length of the rod was divided into two very unequal portions, as a lever having unequal arms. At the outer end of the longer arm he hung a small weight, and at the outer end of the short arm he tied one end of a long cord (or wire), which extended downwards to and had its lower end fastened to the floor at a point almost vertically below the point aforesaid in the ceiling. He arranged the rod almost horizontally by adjusting the length of the long cord going to the floor and the function of that long cord was primarily to supply by its tension a counterbalancing force against the weight on the other arm. So he avoided the use of a second weight, and it is obvious that the small weight at the outer end of the long arm might oscillate in the arc of a nearly horizontal circle, about the centre of oscillation, which was at a point intermediate between the two points of attachment of the cords aforesaid, to the rod (see Fig. 6).

Of course, "torsion" effect was a factor, as well as gravity, in determining the direction that the rod would tend to assume at rest, but he clearly saw the importance of setting his pendulum to oscillate in an inclined plane, for he discusses its angle of inclination, etc., and designed his pendulum to oscillate therein. He set the rod so as to rest in the meridian at noon on a day of new moon, then closed the room, and observed the oscillations of the weight by means of a powerful microscope from outside the room.

He devised also a similar pendulum, having a separate stand, so obviating, if required, the necessity of direct attachment to the building in which experiments were to be made.

With one of his pendulums he claims to have observed lunar attraction effects, and with another, earth rotation effects. His statements as to the diurnal variation which he says he observed are very interesting. More will be heard about such matters presently. He was a pupil of Gruithuisen (*vide* Safarik, Vol. 46, *Phil. Mag.*, 1873). Both master and pupil have been gratuitously villified since their decease by very plausible people, who had ends of their own to serve, by belittling others that they by contrast might appear great.

Hengler was a genius, and by dispensing with the necessity of using a second or balancing weight, as used in the class of so-called "horizontal" pendulums, he opened a new chapter in gravitation research, which is more than his traducers were capable of doing apparently.

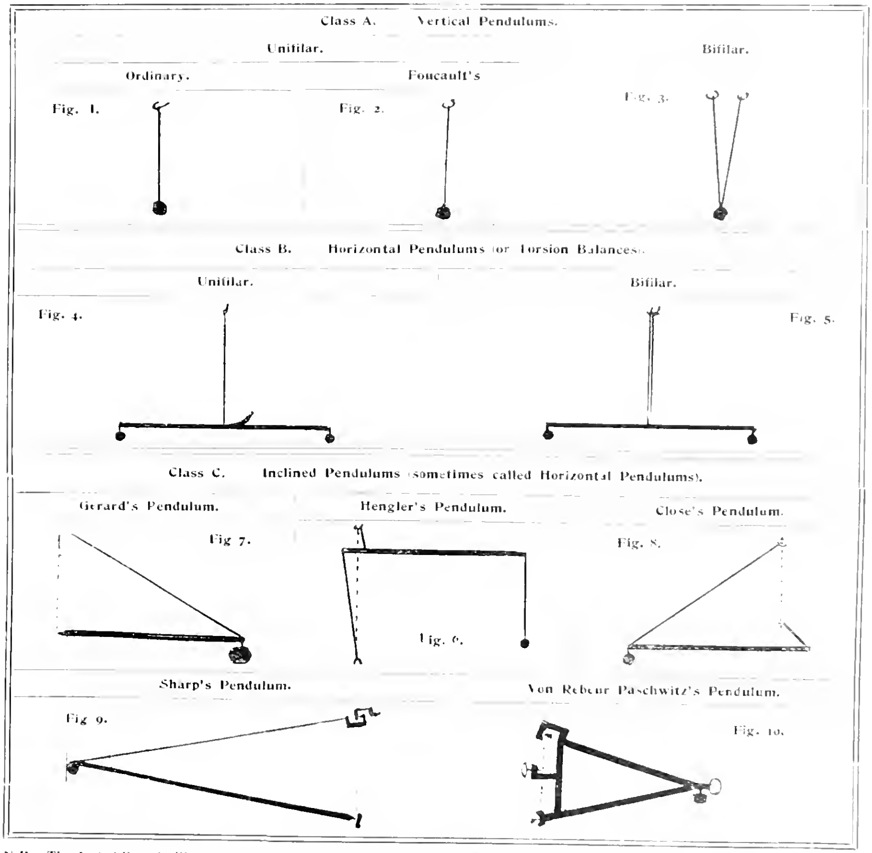
Gerard's Pendulum (1851).—Described as "horizontal," but which had only one weight—about one hundredweight block of granite—at the end of its rod. The rod was a strong composite deal beam, provided with a point at one end, and had the weight hung at the outer end (see Fig. 7). A copper wire was fastened to the weighted end of the "rod," and the other end of that wire was hooked into a ring fastened into a wall. The pointed end of the "rod" pressed against that wall at a point nearly vertically below the ring. The rod was nearly horizontal, and took 15 seconds to make one oscillation. The experiments were made in a room, and diurnal changes of position were noticed by means of an index moving over the surface of a table. The maximum change appears to have taken place on a day "of bright sunshine," and was "as much as one-fifth of an inch." (*Vide Edin. New Ph. Jour.*, 1853.)

That pendulum represents an important step in advance, as regards obviating partially the uncertain position of the real or virtual oscillation centre of previous horizontal pendulums and of those classed as such.

Perrot's Pendulum (1862).—This was practically upon Hengler's principle, but had, like one of his pendulums, a separate stand. The chief difference was as regards the materials used for suspending the rod and counterbalancing the weight carried by the rod. Other differences were merely of detail or accessories. (*Vide Comptes Rendus*, Vol. 54, page 728, for results obtained by its use.)

Close's Pendulum.—The date of this is indicated in "Barrett and Brown's Practical Physics," published in 1862, as being shortly before Zollner's, which latter was invented about 1872. It consisted of a rod, having

Outlines showing principles of suspension or support of various kinds of Astronomical Pendulums,



N.B.—The dotted lines in Figs. 6 to 10 inclusive show the axis of oscillation, and though they appear to be vertical, they must be understood to have the upper end of each axis leaning forward out of the vertical and towards the weight, usually.

a weight at one end, and the rod was suspended from a separate stand, by two unequal silk threads attached to the ends of the rod respectively. The longer thread—from the weighted end—was extended backwards and upwards to a point in the front surface of a vertical support, and was there fastened. The shorter thread was extended from the other end of the rod, forwards and upwards, to a point in the rear surface of the same vertical support, and was there fastened so that the weighted rod hung freely, approximately horizontal, as in an unequal bifilar suspension (see Fig. 8).

Close found his pendulum so sensitive that it was moved through an easily measurable angle if finely adjusted, when the whole ground floor of the house, in the basement of which his pendulum stood, was tilted "over to leeward" by a moderate gale. I know of no other observations made with it or results obtained thereby.

Zollner's Pendulum (1872). This, like Perrott's, was practically upon Hengler's principle. Zollner himself credits Perrott with having invented the "horizontal pendulum," but as he also quotes from Hengler's paper and discredits the results therein reported, it is amazing that he did not credit Hengler with the invention of it, unless he meant to confine the credit to the modifications introduced by Perrott and added to by himself. If so, Hengler's credit is the greater.

Zollner used a separate stand, and made modifications in detail, besides using such long previously well-known accessories as the Gauss mirror, etc. *Vide* "Poggendorff's Annalen," 1873, wherein it may be seen that Zollner's object was to investigate as to the "origin of the earth's magnetism," etc., also the results obtained by the use of his pendulum may thereby be traced.

On the 22nd February, 1880, a great earthquake in Japan, led to a meeting being convened there, and at which the Seismological Society of Japan was established, for the special purpose of investigating earthquakes. From that time, seismology, as a science apparently dates. The importance of seismometry as affecting gravitation research, and *vice versâ*, has not yet been fully realised; nor has the action of bodies outside the earth as affecting both been much more than guessed at, and to a very slight extent definitely experimented upon.

No doubt seismological investigations had previously been made in Italy and elsewhere, for in the *Bullettino*, 1876, page 5, Rossi describes instruments previously used for that purpose; and the experiments of M. d'Abbadie, with a dish of mercury, of Plantamour, with a level, and of Siemens, with the "Attraction-meter," as reported in *Phil. Trans.*, 1876, are distinctly related thereto. But after 1880, a particular distinction specially affecting so called "horizontal" pendulums requires to be noticed.

Previously the characteristic of astronomical pendulums had usually been that the earth's surface in the locality where they were respectively used, together with the building, or rigid support to which they were suspended, was considered as at rest, in relation to the oscillating pendulum weight. But the usual characteristic of seismological pendulums is directly opposite thereto, for the pendulum weight, by its inertia, is supposed to remain usually in relative rest, and to serve as a fulcrum for the pendulum rod which is considered to have its axis of oscillation moving with changes of the earth's surface. In fact, the rod is simply regarded as having the function of a lever in these instruments, and the motion of the stand at one end is either recorded by a writing point or ray of light at the other, or the angular deviation of a ray of light or scale image, by means of the well-known Gauss mirror method, is, if necessary, photographically recorded as magnifying that of the stand, when the mirror is attached to the rod or its weight. Oscillations of short-period earthquake waves, apparently, are chiefly sought to be recorded by means of seismographs in general use.

Ewing's Seismograph (about 1881), described in *Ency. Brit.*, N.S., Vol. 27, page 605, appears to have a seismographic lever, which is therein called a "horizontal pendulum," consisting of a frame of metal working gatewise upon two points, and carrying a large ball of metal, which has a long writing pointer attached. I am not aware of any publication prior to 1881 of such a "two-point" suspension, though I had used such long before without publication, and so far the credit of prior publication of a "two-point" suspension is his to the best of my information.

The "two-point" lateral suspension is a step in advance upon the "ring and one point" lateral suspension used by Gerard, but I have been unable to find an instance of any astronomical or cosmic observations having been made by the use of this instrument, which might benefit gravitation research, nor even of any attempt to apply it for the purpose of such discoveries. That, however, may be due to my having been ignorant even of its existence until I heard of it in July, 1906, as containing a "two-point" suspension. The "suspension" and "frame" are in principle like Fig. 10.

Sharp's Pendulum, invented by the writer hereof about 1875, and used in gravitation research until date of its first publication, in February, 1885 (*vide Jour. L'pool Astron. Soc.*, March, 1885), was essentially an astronomical and inclined pendulum, expressly not horizontal. It consisted of a tube or trussed rod (or boom), having a ball at its outer end, and a needle point at the other, but I now prefer to use a rod having a star or + shaped section when I cannot get suitable tube. A cord or wire of brass, aluminium, or copper, was fastened at the outer end of the rod and carried backwards as a stay to a reversed needle point, forming part of a steel bolt driven into the solid angle of the room walls just below the ceiling. That wire ended in a stirrup, the interior surface of which was hardened, and had a minute indentation made therein with a fine "centre punch." That stirrup was hooked upon the reversed needle point so that the point entered the indentation, and was thereby prevented from sliding out of place. The point of the rod below in the solid angle of the walls, near the floor, rested in a similar indentation in a hardened surface, which was mounted on a compound lathe slide rest, giving definite and convenient control of its position, so that the lower needle point could be brought as was requisite almost vertically below, but a little in rear of the line containing the upper point (see Fig. 9).

The rod formed the lower, and the stay formed the upper, of two sides of an isosceles triangle, of which the third side was wanting, and the pendulum oscillated like a > shaped gate, upon the two needle points as hinges. The needles, of course, were in line with the pressures they had to oppose. With adequate time and patience no difficulty whatever was experienced in obtaining the normal variation curve of daily and monthly lunisolar changes, by direct readings from a scale of millimetres, taken by means of an ordinary pocket telescope, after once suitable conditions had been found. In fact, it was quite possible to take sufficient observations of the index oscillations from the sixteenth of an inch divisions of a common foot rule, by using a pair of opera glasses, to enable charts of lunisolar variations to be obtained.

Of course, the earth and the pendulum ball both move relatively to extra terrestrial bodies, and the recording of earthquakes and tremors might more fitly be entered upon when the larger regular changes are first recognised and charted. Else the diurnal oscillations are liable to confuse the earthquake oscillations. However, these latter have not been my objective, and have not obtruded upon my other work.

It was most convenient to me to consider the pendulum curves as affording comparative and undeniable evidence in themselves without troubling as to whether the ball was at rest and the building oscillating, or the building at rest, and the ball oscillating, or as to whether both were, and to what extent, oscillating. In accordance with the same convention as that by which we regard the Greenwich Observatory at rest, when observations are made through its large telescopes, so far also I was entitled to consider the buildings at rest in which I made my observations. If they moved, Greenwich Observatory (worse situated)* must indeed, have executed serious oscillations involving all its telescopic observations in error.

The advantages of using this kind of pendulum I found to be: (1) It can be made, fixed, and used in any ordinary house, by a person of ordinary intelligence, from common materials, for a few shillings. (2) It gives direct readings, and therefore its evidence is superior to such as might be got by using reflected rays from Gauss mirrors, from photographic recording instruments, or from counting oscillations, and calculating on the assumed accuracy of certain formulæ, and so on. (3) There are no restrictions whatever as to its use, such as patent rights or aught of that kind.

I am not aware of any better means of investigating gravitation, and I say this after having been engaged therein more or less continuously for forty years, solely on my own account, independently, and after recent enquiries as to what others have done in pendulum construction and use.

I use three pendulums simultaneously, one in the meridian plane, one in a plane at right angles thereto, and one with means of observing vertical component.

Von Rebeur Paschwitz's Pendulum (1892).—This so-called horizontal pendulum also has a "two point" lateral suspension. The rod is replaced by a triangular frame after the style of Ewing's seismograph aforesaid, which it much resembles, though it is alleged to have been based upon Zollner's pendulum, which it does not resemble save perhaps in regard to the use of a Gauss mirror, and angular deviation therewith of a ray of light. In fact, it is a seismograph, and has been very widely adopted for seismographic purposes, although Paschwitz himself made observations with it upon the variations of gravity, etc. (see Fig. 10).

It must be understood that in using pendulums of any of the above descriptions involving points working upon bearing surfaces, the rod may have the point, and the wall or support may have the bearing surface, but if more convenient, the rod may have the bearing surface, and the wall or support may have the point. Also it is obvious that any pendulum may have a Gauss mirror attached, in order to use the angular deviation of a ray of light or reflected scale image for magnifying its motion, and that recording apparatus of any kind—automatic, photographic, or otherwise—may be used as convenient. Stands, set screws, and levelling or adjusting devices are useful, but by no means necessary. I prefer to use aluminium, or brass tube for the "rod" or "boom."

There is no doubt that each of the pendulums herein named were independently invented to suit the special enquiries, available materials, and environment of their inventors, as the literature of pendulums is comparatively limited, and what there is of it is very difficult to find, and almost inaccessible, owing to the vast accumulation of literary matter in which it is buried in different places over a very great area.

At a future date, with the editor's permission, I may give some charts of lunisolar observations, taken with my pendulum, and give the results of my experience as regards the best method of erecting, adjusting, and using pendulums for making same.

* My latest observations were made here in 0° 3′ E. Lon., 51° 32′ 40″ N. Lat., 19 feet above Trinity high water mark and three miles from nearest part of tidal river Thames.

CORRESPONDENCE.

Electrical Nitrates and Fertilisers.

To the Editors of "Knowledge & Scientific News."

Sirs,—The article under the above heading in your last issue opens with the following sentence:—

"At present the world's wheat supply depends chiefly on the continued productiveness of a strip of territory in Chili."

With all due deference to the writer of the article, I would point out that this statement is very far from being correct. Nitrate of soda is, no doubt, being worked in increasing quantities in Northern Chili, and there is a large demand for it as an artificial manure. Probably less of this fertiliser is, however, applied to wheat than to any other important crop. Nitrate of soda in British farming is applied principally to turnips, mangels, cabbages, and grass, much less commonly to any corn crop.

Wheat is in no sense dependent for its profitable cultivation upon nitrate of soda.

The value of calcium cyanamide as a nitrogenous manure as compared with sulphate of ammonia has been tested at Rothamsted Experimental Station, and an account of the experiments will be found in the "Journal of the Board of Agriculture," for July last.

I am, yours etc.,

J. H. M. H.

Electrical Bleaching.

There is good reason for believing that the excessive whitening of flour deprives it of its nutritive qualities. Nevertheless, devices for bleaching it continue, and an electrical method is cheap and is said to be successful. A current of air is passed through a closed chamber, in which is a long high-voltage electric arc. The air thus electrically burnt is then passed through the flour as an agitator, and becomes whitened in the process. Presumably the discharge of the electric arc produces compounds of nitrogen and oxygen in the air which act as bleaching agents. This method is essentially different from the other electric processes of bleaching flour by ozonising the air passed through it. In that process the air passes through a chamber in which there is a silent electric discharge. A combination of the two processes is suggested, the ozonised air being subsequently burnt by the arc discharge. A machine has been patented, and is actually in use.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Photographic Exhibitions.—The annual exhibition of the Royal Photographic Society at the New Gallery, 121, Regent Street, is now open, and will close on the 27th of October. All sections are of interest and are well represented, but we naturally turn to the technical section. The preponderance of photographs of birds continues, if it does not increase. Nature, as we know it, does not consist chiefly of birds, but one or two indefatigable workers appear to have set tre fashion in this direction, and a considerable number of photographers, the most of them less skilful than their leaders, have followed in the groove. The time is past for showing an isolated photograph of a bird, unless it is a very rare specimen or has some very special reason for its exhibition. Mr. W. Farren's series of twenty-four photographs, showing the life history of the stone-curlew, and Miss E. L. Turner's grebe series, are highly commendable. A few years ago, similar series, illustrating the growth of certain plants were shown, but this year Mr. A. W. Dennis contributes a series of a different kind. He illustrates wych elms, and fine examples of them, in their different conditions as to seasons, and also, on suitable scales, the various details of their parts, such as the winter buds, the leaf, the blossom, the fruit, etc. A most interesting exhibit to those whose knowledge of the aberrations of lenses is not very precise, is a series of models made by Mr. Welbourne Piper, that clearly illustrate the paths of the rays under various conditions by means of threads of different colours. There are nearly three dozen models on the six frames. For this new departure in the illustration of the effects of lenses that are of prime importance in photography, the judges have awarded a medal. We look in vain for any evidence of progress in the department of colour-photography. The best of the examples are not better than what has been seen before. An invitation collection includes recent work from the Greenwich Observatory and the Solar Physics Observatory, Dr. W. J. S. Lockyer's series of cloud photographs, a large series of photographs of electrical discharges by Mr. K. J. Tarrant, further work by Mr. Edgar Senior on the Lippmann method of colour photography, and other exhibits of much interest. In the North Room there are several examples of "ozobrome" prints, with the bromide prints from which they have been produced.

There are two other exhibitions now open in London that are of great interest to those who photograph, though not from a scientific point of view. The "Photographic Salon," at the Gallery of the Royal Society of Painters in Water Colours, 5a, Pall Mall East, is devoted entirely to pictorial work, and closes on the 27th October. A collection of portraits by the late Mrs. Julia Cameron, and by her son, Mr. H. H. Hay Cameron, will be on view till the 6th of October, at 24, Wellington Street, Strand. These pictures of Mrs. Cameron's include some of the finest photographic portraits (and one might perhaps almost omit the word "photographic") ever produced, and of the finest subjects, for there are portraits of Carlyle, Tennyson, Browning, Longfellow, Darwin, Sir John Herschell, Joachim, Watts, and Miss Ellen Terry at the age of seventeen.

The Purchase of Photographs.—The greater number of the photographs in the exhibitions above referred to can be purchased, as is usual in picture exhibitions. During the last ten years, or rather more, it has become fashionable to omit all reference to the nature of pictorial photographs, that is, what the image consists of, or how it has been produced, for fear, I suppose, lest they should be bought as specimens of processes instead of because of their pictorial merit, or for fear the artist should feel handicapped in their production, not always knowing himself what his methods lead to. There are many photographers who take great care that their pictures contain nothing but what may fairly be called permanent, but others are not so scrupulous. A fine effect may be obtainable in fugitive material, and through ignorance or indifference they avail themselves of a process or a detail in the process that they ought to absolutely shun in any picture that is offered for sale. As the possible variations in photographic methods are more numerous than in any other current method of pictorial expression, this reticence is a distinct disadvantage to the would-be purchaser and doubtless also to the photographer.

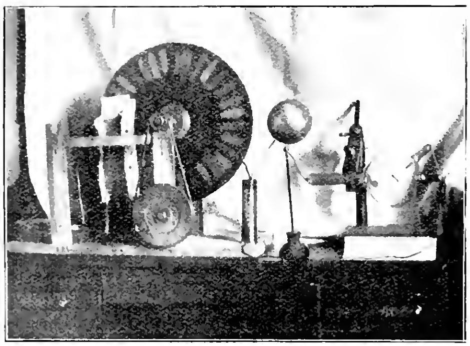
Colour Photography.—Professor Lippmann has recently described in the *Comptes Rendus*, another method of colour photography. A plate that is opaque, except for fine parallel lines, about 125 to the inch, is fixed at one end of a light-tight box, a photographic plate is at the other end, and a lens between is so arranged that it forms a sharp image of the grating on the plate. A small angled prism is fixed near the lens so that the light that passes through each line (as through the slit of a spectroscope), is dispersed into a spectrum, but so short a one that it only just covers the otherwise blank space between the image of one light line and the next. Instead, therefore, of a series of separated fine lines on the plates, the surface is covered with lines of colour, very much as if a Joly compound colour screen were in front of it, but there is a spectrum instead of each group of three coloured lines. An image of the coloured object that is to be photographed is projected by ordinary optical means on to the grating, the exposure is made, and the plate developed. By putting (I suppose) a positive, made from the negative in exactly the place occupied by the negative during the exposure and illuminating it with white light, a coloured image, similar to the one photographed, will be produced in the plane originally occupied by the grating. It is obvious that the ultra-violet must be excluded, the plates must be sensitive to the whole of the visible spectrum, and other precautions must be taken that need not be enumerated. It is a pretty and interesting method that must need very nice manipulation to ensure success.

Colour-Sensitised Plates.—Messrs. Wratten and Wainwright send us a sample of their "Allochrome" plates, which are sensitised for green and yellow, but not for red, and are thus comparable with the colour-sensitised plates that are best known and made by many makers. The sample is of excellent quality and backed with a black backing that does not detach itself, but is easily removed when done with. This, with the plates referred to before, makes a very complete series, and a booklet that the firm have just issued describes the many kinds of plates that they make, including five varieties of plates specially sensitised for colour, and gives advice as to their use. Colour screens or filters of various kinds and of three densities, specially suitable for use with the plates, and others for three-colour work, are issued by the firm.

The Celluloid Electric Machine.

By Charles E. Benham.

The value of celluloid as an electric has hardly been fully realised, and the use of it has, perhaps, been prevented from considerations of its inflammability. There is no danger whatever on that score in employing it in the manner about to be described. The electric properties of celluloid are somewhat mysterious. It is not a particularly good non-conductor, yet at the least friction with silk or other suitable rubbers it is highly electrified. Its electric potency increases, and often a sample that is quite new will hardly give any electricity, and yet after a few weeks it becomes powerfully excited by friction, and Dr. J. N. Goldsmith, of the Xylonite Works at Brantham, states that this increase of efficiency goes on to a maximum, and then, after a course of many years, gradually declines. It is not nearly so sensitive to atmospheric conditions as glass or most other electrics, and the machine about to be described will start readily under ordinary conditions without any preliminary warming. The spark is not, of course, so strong in wet weather, as is also the case with the influence machine, but the falling off is probably due to the defective insulation of the parts of the machine under such circumstances rather than to any difference in the action of the celluloid itself.



The Celluloid Electric Machine.

[The illustration shows a machine with two 16-inch glass plates, mounted about half an inch apart on one spindle. The outer surfaces of the plates are varnished with celluloid, and each is lightly pressed by a silk cushion seen on the left. The inner surfaces of the discs have tinfoil sectors which are earthed by a brush placed between the plates where they pass the silk rubbers. The prime conductor is connected with a small Leyden jar, a pointed wire projecting from it between the discs to collect the charge from the sectors. The attachment for the X-ray tube is also shown. One terminal of the tube is connected with a small insulated brass ball, placed about half an inch from the prime conductor. A wire is led from the other terminal to the outer foil of the Leyden jar.]

In the April number of "Knowledge" a simple gas lighter made of celluloid was briefly described, and it may be mentioned that such a device may be made equally well, or, perhaps, with advantage, by employing a glass tube coated with celluloid instead of a tube composed of that material. Celluloid is readily soluble in amyl acetate, and the varnish thus formed may be applied to glass, and when dry there will be a very tenacious film of celluloid on the surface which becomes highly electrified under the influence of a silk rubber.

Instead of coating a glass tube in this way, the surface of a glass disc may be varnished with celluloid, and a very efficient plate machine of extremely simple design may thus be constructed.

It should be mentioned here that a curious mistake is made in the construction of the old "plate machine," which, of course, is not often seen nowadays except in class-rooms as illustrative of electric principles. This mistake consists in the use of two rubbers—one on each side of the glass. If one rubber on one side of the glass is used and in place of a rubber on the other side an earthed brush grazes the glass, there will be quite as much electricity produced as with the two rubbers; while much less friction is involved. The brush increases the capacity of the plate where the rubber is applied, and a second rubber, instead of the brush, only does the same thing less effectively. The side away from the rubber and touched by the brush may advantageously be furnished with tinfoil sectors. Each sector passing the brush when it is under the influence of the rubber has its capacity largely increased, and when free from the brush, passes the collectors with correspondingly reduced capacity, and, consequently, yields its charge to them readily. This applies quite as much to the old-fashioned plate machine as to the celluloid machine, and it is strange that the arrangement never seems to have been adopted.

The celluloid machine is made upon the plan just described, the rubber being of silk, and no amalgam being used. Japanese silk is particularly good for the purpose. There is also no special advantage in making the plate pass the rubber twice in the course of a revolution, as in the Ramsden plate machine. Winter's plan of single collectors for each revolution will be found the best. It is equally a question whether any advantage is gained by making the collectors embrace both sides of the glass. Experiments do not at all indicate that there is any increase in the output thereby.

All these considerations make it clear that for an efficient machine the construction will be of the simplest kind with the accompanying advantage of a minimum of leakage, which is sure to be introduced together with any unnecessary complications of the apparatus and an increase of the number of parts. The revolving disc, turned with winch and pulley, passes a silk rubber pressing against the left side of the disc, and at the same spot the sectors on the opposite surface are successively earthed by a brush. Passing round, the sectors deliver their charge to the collectors, a row of points connected with a prime conductor and facing the sectors on the right hand side of the disc. Care must be taken that the rubber presses only lightly against the glass, so as to avoid any risk of breakage. The celluloid varnish is applied to the back of the glass only, and should not be brought up to the centre of the disc, for, as already stated, it is not a very good insulator. All the rest of the disc, except, of course, the surface of the tinfoil sectors, should be coated with shellac varnish.

A more powerful machine may be made by using two such discs with the tinfoil sectors facing each other. The two discs should be mounted on the spindle so that they are about half an inch apart. A rubber is placed against each disc on the outside surfaces at the left, a double brush on a wire support being fixed between the two discs so as to touch the sectors of each simultaneously. The collector is simply a pointed wire projecting from the prime conductor, so that its point is between the two discs on the right hand side. Attaching a small Leyden jar to the prime conductor a very strong spark, well suited for X-ray work, is obtainable. The spindle may be made long enough to carry further pairs of plates in the same way, with increased output. To regulate the pressure of the rubbers, they should be on hinged supports so as to be quite free to yield to outward pressure, while a curved springy piece of thin brass wire is made to clip lightly the two supports and thus hold the rubbers pressing gently against the glass.

NOTES

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Mills Expedition to the Southern Hemisphere.

At the close of the two-year period of actual observation in October, 1905, by the D. O. Mills Expedition to Santiago, Chili, Mr. Mills most generously offered to continue the work for five additional years. He has also provided for extensive improvements in, and additions to, the equipment of the Observatory. Two-prism and one-prism spectrographs have been built, in order that radial velocity determinations may be carried to the fainter stars. Professor Wright's experience has made it practically certain that rapid changes in focal length and other sources of disturbance in the stellar images are due to rapid changes of the temperature of the mirror during the first hours of the night. Dr. Curtis has designed a refrigerating apparatus, which has been sent to Cerro San Cristobal for trial. It is hoped that by the use of this the apparatus may be kept at a sufficiently constant temperature.

Accelerated Motion of Jupiter's Great Red Spot.

Mr. W. F. Denning, writing to the *Observatory* for September describes some recent observations he has made on the Great Red Spot on Jupiter during the present year. Towards the close of the last opposition, March to May, 1906, his measures showed that the rate was as nearly as possible conformable with that of System II., based on a rotation period of 9h. 55m. 40.6s. On re-observing the planet before sunrise on August 9, however, he immediately saw that the Red Spot and Hollow were far in advance of their predicted places. This was confirmed by the Rev. T. E. R. Phillips on the morning of August 11, and by another observation obtained by Mr. Denning on August 16, showing that in a period of little more than three months the markings have lost 16°, equivalent to 26^{m} 29^{s}, relatively to the zeromeridian of System II. In other words, while the rotation between March 24 and May 4 was 9h. 55m. 40.6s., it had become only 9h. 55m. 33.8s. between May 4 and August 8. The latter period is the same as that exhibited by the Red Spot during 1879.

Mr. Denning notes that the dark material (extending over about 63° in longitude), forming the South tropical disturbance on Jupiter, must have been in central conjunction with the Red Spot in June last, and he thinks that it may have been responsible for the marked increase of velocity shown by the latter. Even then the recent acceleration in the motion of the Red Spot is far greater than has ever been previously observed, and either the Hollow in the South Equatorial belt or the Red Spot appear to have been visible for the past 75 years.

Recent Observations of Phoebe.

In the 118th Circular of the Harvard College Observatory, Professor E. C. Pickering gives the reductions obtained from six photographs of Saturn's satellite, Phoebe, during this year. They were taken during May and June, with the 24-inch Bruce telescope, at Arequipa, the plates being exposed for about two hours each. The following table shows the co-ordinates of the satellite at the times noted :—

Date.			G.M.T		Distance.	Position. Angle.
			H	M	′	°
1906.	May	18	21	3	25·7	245·0
	,,	19	21	7	25·7	244·7
	June	25	19	0	23·3	247·3
	,,	26	18	55	23·2	247·2
	,,	27	18	59	23·0	247·1
	,,	28	18	53	22·9	246·9

The System of Castor.

Mr. H. D. Curtis gives a complete discussion of the Lick Observatory plates of the spectrum of α Geminorum, Castor, with correlative comparisons with the measurements made at Pulkova, by Belopolsky. Most of the plates were taken with the re-mounted Mills spectrograph, with λ4,500 central, the region of spectrum investigated extending from λ4307.839 to λ4629.521. Both components of the star are of the Sirian type, being catalogued in the Harvard classification as A and VIIIa. The absorption is somewhat more complete in α_1, the fainter component, than in α_2. The plates for measurement were exposed for eighteen minutes to the brighter component, and forty-four minutes to the fainter component.

α_1 Geminorum: fainter component, south preceding; magnitude, 3.7.- The binary character of this component of Castor was discovered by Belopolsky at Pulkova, in 1896. The elements deduced from the Lick plates are :—

Period = 2·928285 days.
τ = J.D 2416828·057 ± 0·042 days.
e = 0·01 ± 0·0066
μ° = 122·939
ω = 102·516 ± 5·120
κ = 31·76 ± 0·22
Velocity = − 0·98 km. ± 0·15 km.
a Sin i = 1,279,000 km.

α_2 Geminorum, brighter component: north following; magnitude, 2.7.—The variation in the radial velocity of this component of Castor was discovered by Curtis in October, 1904. The final elements of the orbit are :—

Period = 9·218826 days.
τ = J. D. 2416746·385 ± 0·021 days.
e = 0·5033 ± 0·0112
μ = 39·05053 ± 0·00046
ω = 205·353 ± 1·730
κ = 13·557 ± 0·218
Velocity = +6·20 km. ± 0·17 km.
a Sin i = 1,485,000 km.

The author expresses the hope that a combination of the spectrographic and visual results will eventually give a fairly accurate value of the parallax, masses, and other physical constants of this unique quadruple system; at present the elements of the visual orbit are so indeterminate that no conclusion can be reached at present. It is important to note that in Castor we have two systems whose orbital dimensions are probably of the same order of magnitude. The brighter component has, however, the very great eccentricity of 0.50, while the fainter pair revolve in orbits which are practically circles (e=0·01). This extraordinary difference seems, by the generally accepted theories of stellar evolution, to indicate that the brighter component is the older, and that the fainter is, comparatively speaking, a binary of relatively recent origin. The effect of tidal friction on a system so eccentric as that of α_2 must be enormous, as at periastron the stars are only about one third their apastron distance apart. Such an eccentricity has only been found in those spectroscopic binaries which show variability in their light. A special series of observations were accordingly made with the smaller of the two Bruce double-image photometers, attached to the twelve-inch equatorial. No marked variation of regular period could be detected, so that any existing must be very small. No irregularities have been detected in the velocity curve of the spectrographic orbit.—(*Lick Observatory Bulletin, 98.*)

New Optical Catalogues.

Adam Hilger, Ltd.—In their latest catalogues, Messrs. Hilger present several important novelties for the consideration of the spectroscopic or astrophysical worker. The list "A," in addition to numerous forms of spectroscope of improved design, contains descriptive illustrations of several new departures in spectroscope designing. For much too long a time the spectroscopic apparatus supplied even for critical research has been made of too light design, resulting in difficulties due chiefly to flexure, and also temperature changes induced by the variety of materials employed in construction. The Hilger "Bar" Spectrograph has been designed to eliminate many of these defects, and a critical examination convinces one that it is sure to give satisfaction, especially for photographic work, where rigidity is so specially necessary. The mounting consists of two triangular bars, connected at their intersection with a thoroughly good, long, conical fitting. The bars are accurately scraped to standard gauges, and on them are mounted the massive carriers for the lenses, eyepieces, prisms, etc. A specially designed clamp is provided for locking each piece in any desired position. As made, the instrument can be provided with either prism or grating, being practically a universal spectroscope or spectrograph. For the optical parts, Messrs. Hilger are prepared to supply prisms made of the new "Uviol" glass, prepared by Schott and Co., for ultra-violet work, but as it does not pass light as far as a quartz-calcite train, it is not recommended for standard work.

The well-known "Evershed" spectroscopes for prominence and spectrum work on the sun, and the new form of Hüfner Spectrophotometer also deserve special mention, but particulars of numerous other pieces of physical apparatus are included.

List "B" contains particulars of the Echelon gratings usually supplied, the largest consisting of 40-plane parallel plates. All these are generally supplied with the auxiliary spectroscope, which is necessary for isolating the particular radiation under investigation. The *Constant Deviation* spectroscope, which is a speciality of the firm, is well adapted for this purpose, and several different methods of arranging the apparatus are suggested.

Carl Zeiss.—The catalogue of astronomical telescopes and accessories just issued by Messrs. Zeiss gives minute details of their instruments, all presented with that beautiful finish always associated with the products of the firm. The views of the erecting shop, where instruments are built up and thoroughly tested before sending out, and the well equipped observatory, where all the objectives are used on the actual celestial objects, all emphasise the care which is taken to produce only one quality, and that the best. The list includes refracting and reflecting telescopes, objective prism spectroscopes, prominence spectroscopes, and all the usual small apparatus of an observatory.

BOTANICAL.

By G. MASSEE.

Vitality in Seeds.

A HIGHLY interesting and well authenticated account is given by Landreth, in *Proc. Amer. Phil. Soc.*, No. 182, of an instance of persistent vitality in seeds. Lieutenant Greely, Commander of the Lady Franklin Bay Expedition, which sailed north in 1881, took out seeds of various vegetables noted for their antiscorbutic properties. Some of these were sown at Fort Conger, 81° 44′ north, but the attempt was not successful. This station was abandoned in 1883. In 1899, sixteen years later, the abandoned station at Fort Conger was discovered by Lieutenant Peary, Commander of the North Polar Expedition. Among other things found was a packet of radish seed in an open box in the attic of the Fort.

These seeds had been exposed during sixteen years to a winter temperature of 60° to 70° F. below zero. The seeds were sent home and remained until the spring of 1905, when they were sown and 50 per cent. produced perfectly normal plants. The original seed was harvested certainly not earlier that 1880, and consequently was twenty-three years old when sown. The question is raised as to whether the electrically charged atmosphere, so constant in northern regions, has the effect of prolonging germinative force. It has been observed that the atmospheric electric currents add quite 100 per cent. to the rapidity of plant growth, and to the development of colour and strength of perfume.

Response to Stimuli in Plants.

Dr. Bose has on previous occasions published some interesting and novel ideas relating to the response manifested by plants to electrical stimuli. In a book entitled "Plant Response as a Means of Physiological Investigation," he fully explains the results of his researches on this subject. The phenomena of fatigue, rhythmic response, polar effects of electric currents, transmission of stimuli, etc., can be demonstrated in plants exactly as in animals, thus proving that the underlying law concerning response to stimuli is identical in the two kingdoms. This conception is the leading idea of the author, and is supported by numerous refined and original methods of research, which are fully explained. Many new and highly ingenious instruments have been devised for such purposes as recording simultaneously the response of two plants placed under varying conditions; for recording the death-spasm of protoplasm, etc. Response in whatever manner expressed, resolves itself into two simple and well defined factors, namely, contraction and expansion. The former is the direct result of stimulation, the latter being the indirect result.

Growth is collectively a multiple response to various stimuli. Death is the outcome of a sudden and irreversible molecular change, accompanied by contraction.

Burmese Lacquer Ware and Burmese Varnish.

A very interesting account is given by Sir George Watt, in the *Kew Bulletin*, of the beautiful examples of native workmanship, in which Burmese lacquer or varnish plays an important part. This substance is furnished by a large deciduous tree, *Melanorrhoea usitata* (Wall.), met with in the open forests of Manipur, Burma, and Siam, and bears the following vernacular names: *thit-si* or *thit-tse* (Burm.), *khéu* (Manipur), *sathan* (Taleing), *kiahong* (Karen). In British Burma, the lacquer-ware is of two kinds (1) in which the article is made of basket-work lacquered over; (2) that in which the article is made of wood, such as the large round platter, with a raised edge, in which dinner is served, round and square boxes, bowls, etc.

For basket-work, strips of a bamboo known as *Tinwa-Cephalostachyum pergracile*, are most frequently used. The baskets with their trays and covers, are so accurately plaited that the rest of the work can be done on a lathe. The interstices of the wicker are then filled with clay and painted with varnish, which penetrates and toughens the clay, and binds the fibres of the wicker. It is afterwards ground smooth on a lathe and various coats of varnish applied.

In some instances the entire surface of an article is covered with engraving. The gloss of the varnish is removed and a perfectly smooth surface produced. It is then handed over to the engraver, often a young girl, who, by means of a fine metal point, engraves a certain portion of a pattern, the spacing and assortment being done by the eye without any previous sketch or copy. The article is then rubbed over with some dry metallic pigment which loads the engraved portions with colour, the excess is rubbed off and the colour fixed by a coating of varnish. This process is repeated time after time until the pattern is completed and the various colours desired have been introduced, after which one or two final coats of varnish completes the work. In some examples gold leaf is pressed into the partially dried varnish, which produces gold lacquer.

In Mandalay, and elsewhere in Upper Burma, the resin, after being thickened with rice husk or cow dung ashes, is used for moulding. The material is moulded between the fingers into the form of the bodies of animals, etc., and the details worked in with wooden modelling tools. This method is also used for the ornamentation of fancy boxes, idol thrones, portfolio covers, etc.

Finally, there are the Burmese glass mosaics, or the art of wall decoration by coloured glasses imbedded in the specially prepared varnish. In many instances most elaborate designs have been traced on walls or around pillars, and as the material sets firmly it is very durable.

In conclusion, the author remarks that the varnish is of great merit and immense possibilities, and up to the present practically takes no part in the arts and industries of Europe and America.

Rate of Growth of a Seaweed.

The giant kelp, *Nereocystis luetkeana*, common on the shores of North-West America, sometimes reaches a length of 50 to 80 metres, and the rate of growth as recorded by T. C. Frye, in the *Botanical Gazette*, is as follows :— "The plant lives for two years; during the first year it attains a length of 1.25 to 2.5 m.; during the second year an average increase of 18 m. in length is made between the middle of March and the first of June, a period of about 70 days, which works out at an average of over 25 cm. a day, and about 0.175 mm. per minute."

This rate of growth is between one-third and one-fourth as rapid as that reported for the bamboo, and far above that of ordinary plants.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Upas Arrow Poison.

THE upas tree, *Antiaris toxicaria*, which grows in Borneo and other East Indian islands, has long had an evil reputation, and it is still a common belief that birds flying within the influence of its poisonous vapours instantly perish, and that it is fatal for animals or men to rest beneath its shade. As is the case with many another fable of natural history, there is some groundwork for the exaggerated reports of the evil effects of the upas tree, for it resembles certain *Rhus* plants in emitting a volatile substance which affects the skins of certain susceptible persons coming near it, though others are quite unaffected. There is no question, however, as to the poisonous nature of the sap of the tree, and it is the chief substance used by the Dyaks of Borneo for poisoning the tips of their darts. An interesting account of their method of preparing and using the poison has been given by Mr. John Allen to the Manchester Literary and Philosophical Society. An incision is made in the bark of the tree and the milky exudation collected on a palm leaf and dried first in the sun and then over a fire until a thick brown mass is left. In this state it can be kept without the poison deteriorating, and when required for use it is made into a thin paste with the juice of "tuba" root (which is used to stupefy fish), or with tobacco or lemon juice, and the ends of the darts dipped into the mixture and dried. These darts are made from the middle stem of the palm leaf and are about six or eight inches in length and of about the thickness of a knitting-needle. They are used with a wooden *sumpitan*, or blow-pipe, which is about seven or eight feet in length and has an internal diameter of about ¼ inch. A bird struck by one of these little darts is instantly killed, and a pig dies in about 20 minutes. The fresh juice of the upas tree, whether swallowed or injected into the blood, acts as a violent poison, causing convulsions and death from paralysis of the heart. It was shown some years ago by MM. Pelletier and Caventou that the active principle in the juice was a substance which they termed *antiarin*, $C_{14} H_{20} O_5$. It was crystalline and soluble in alcohol, and when heated with dilute acid was decomposed into glucose and a yellow resin. Another poison prepared from the roots of *Upas tieute*, a climbing plant, is in less common use as an arrow poison. Its action is still more deadly than that of *Upas antiaris*, and its effects resemble those produced by strychnine.

Early English Gunpowder.

A bucket containing bullets and gunpowder has been discovered in the roof of Durham Castle, where it is believed to have been walled up about the year 1641, when the castle was being prepared to withstand a Scottish raid. The bullets are moulded spheres of two sizes, and, according to the analyses of Messrs. Silberrad and Simpson, consist of a little over 99 per cent. of lead, with iron and silver and traces of bismuth, arsenic, and antimony. The gunpowder is not granulated like that of the present day, and was evidently prepared by simply mixing the ingredients. It contains about 1 per cent. of moisture, and the proportion of the constituents calculated on the dry powder is practically identical with that of the black gunpowder of to-day, viz., nitre, 75 per cent.; carbon, 15 per cent.; and sulphur, 10 per cent. It is pointed out by Messrs. Silberrad and Simpson that this is a remarkable fact, since the gunpowders made in England at that time contained a considerably larger amount of sulphur. The only gunpowder with the modern proportions in use in the 17th century was Prussian musket powder, and hence it is suggested that the Durham powder was probably of Prussian origin.

Calcium Hydride.

A new method of preparing calcium hydride, which will find its chief use in the production of hydrogen for balloons (see "KNOWLEDGE & SCIENTIFIC NEWS," this vol., p. 542), has been patented in this country. The metallic calcium is melted in an iron pot, and hydrogen conducted into it while it is in a state of fusion. The gas is absorbed rapidly, and the resulting product, which contains about 84 per cent. of pure calcium hydride, is cooled and broken into large lumps.

The Blue Colour of Water.

The intense blueness of the water in the reservoirs near Purley Station must have puzzled many who have looked down upon it from the adjacent downs, and have given rise to various guesses as to its cause. The real explanation, however, of the blue and green colours found in natural waters has been supplied by the experiments of M. Spring, of Liége. He finds that lime compounds impart no colour of their own, and are not the cause of the brilliant blues often seen in chalky waters, but that the colour is due to diffraction of the light by invisible particles still present in the water after the removal of all colouring matters. Yet the lime compounds play an active part in eliminating iron compounds and humic substances, which prevent the natural blue colour of the water from being seen. The fact that all calcareous waters are not blue is due to there sometimes being formed a state of equilibrium between the purifying action of the lime salts and the constant influx of humic and iron compounds, which mask the blue colour by their own brown tint.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Pliocene Beds in Iceland.

THERE is a fossiliferous deposit on the west coast of Tjornes, northern Iceland, which has been known to geologists for nearly 160 years. The molluscs found in it indicate a much milder climate than now, and the deposit was considered by Gwyn Jefferys and Searles Wood to be not younger than Middle Red Crag. Dr. H. Pjetursson now finds that at a height of above 500 feet above the sea, these beds are overlain by the "eastern basalts," being indurated and altered by them, and resting on some of the "older basalts." Thus there is an intercalation of a fossiliferous deposit of over 500 feet thick, occupying part of the great gap between tertiary and pleistocene rocks, whilst the latter contain indurated ground moraines. The oldest basalts of Iceland are thought to date from early tertiary times, and the occurrence of glacial deposits amongst the younger lavas, together with the fact that the island is still a centre of volcanic disturbance, furnish evidence of a remarkably protracted period of volcanic activity.

Trilobites from Bolivia.

Some interesting trilobites were obtained by Dr. J. W. Evans in Bolivia in 1901-1902, and these have been recently described by Mr. Philip Lake.

Several horizons are represented by these fossils. Two specimens of *Peltura*, probably from the Upper *Lingula-*

Flags, were collected at Cochaiya, about 3 miles north-east of Pata. New species of *Symphysurus* and *Trinucleus*, probably of Arenig age, were found about a mile from Apolo, Province of Caupolican. An indeterminable species of *Ogygia* was obtained from the right bank of the River Caca, in the same province. *Phacops* cf. *arbuteus*, *Dalmanites Paituna*, and *D. Maecurua* were collected in the track from Apolo to San José de Chupiamonas, also in the province of Caupolican. The nodules from which they were derived are probably of Lower Devonian age. It is worthy of remark that, while the earlier forms show affinities with the contemporaneous European fauna, the Devonian species are much more closely allied to those of South Africa and North America.

Vegetable Structures in Coral Reef.

Considerable interest is being shown in the light thrown upon the origin of limestone in the researches conducted by Messrs. Frederick Chapman and Douglas Mawson, in regard to the importance of *Halimeda* as a reef-forming organism. The freshwater *Chara*, calcareous algæ, nullipores, and purple sea-weeds of the type of *Lithothamnion* have long been known to form the basis of limestones and coral-reefs, but in *Halimeda* we have a calcareous green alga performing a similar operation. The material obtained in the great boring, the lagoon-borings, and lagoon-dredging at Funafuti has yielded a considerable quantity of *Halimeda*; and Dr. Guppy has described a *Halimeda*-limestone in the Solomon Islands. Evidence such as this shows that the important deposits of calcareous plant-remains forming at the present day can scarcely be paralleled by any deposit formed in past geological times, except, possibly, the limestones of the Alpine Trias, which owe their origin to the thallophytes *Diplopora* and *Gyroporella*. Among other *Halimeda*-limestones may be mentioned those of Christmas Island, Fiji, and Tonga, and the New Hebrides, but these differ considerably one from the other in the condition of preservation of their chief organic contents. *Halimeda* seems to be more liable to decay than *Lithothamnion*, corals, or foraminifera, and yet it appears to retain its structure to a considerable depth in reefs. Much of the fine powdery limestone associated with coral-reefs, and more especially with upraised coral-islands, may be primarily due to lagoon and other deposits formed by the agency of *Halimeda*.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c

Herons and Fish Preservation.

Some little time since, the Dart District Fishery Board issued urgent appeals to the owners of heronries to reduce the number of their herons on account of the damage supposed to be done by their ravages.

The members of the Board do not seem to have been very well informed on the matter, as is usually the case. For the replies to their requests showed that at least one heronry existed only in the imagination of the Board, while another boasted but half-a-dozen birds, which the owner rightly refused to interfere with. As a matter of fact, the evidence all tended to show that the heron was by no means a common bird on the Dart.

We cannot but regret the fact that sport should so commonly go hand in hand with greediness. This stately bird is one of the few remaining relics of our native fauna which has been slowly strangled to ensure larger bags to the "sportsman." Happily, however, there are many who, while keen sportmen, are no less keen naturalists, and to them we owe what is left to us of our larger native birds and beasts.

Red Crested Pochard in Norfolk.

Mr. N. Herbert Smith, in the *Field*, September 15, records the fact that a pair of red-crested pochards (*Netta rufina*) were killed by his keeper at Hickling, on September 8. The first record of this bird as a British species dates back to 1818, when a female was killed on Breydon Water, in Norfolk, in the month of July. The present example made the tenth record for this county.

Nine other examples however, all males, have now to be added to this list. The Rev. M. C. H. Bird, records the fact in the *Field*, September 22, that nine adults, six males and three females, of this species were killed on September 4, out of a flock of thirteen, on Breydon Water, Great Yarmouth. "Supposing," Mr. Bird writes, "as is probable, that the pair killed at Hickling on September 8 . . . were part of the above company, only one of the 'bakers' dozen' of these rare visitants remains unaccounted for." To this the editor of the *Field* pertinently remarks: "What a pity it is they should have to be 'accounted for,' instead of being left alone to delight hundreds of other people besides the shooter!"

Hoopoe in Cheshire.

Mr. Alfred Newstead records (*Field*, September 15) the fact that a hoopoe was captured near Chester on August 23, and remarks that this is only the third known instance of its occurrence in Cheshire.

Alpine Swift in Devon.

Two Alpine swifts (*Cypselus alpinus*) are reported (*Field*, September 22) to have been seen about a mile from Exmouth during August. The large size of these birds, and their very distinctive coloration, makes it unlikely that any mistake has occurred in the correctness of this record.

PHYSICAL.

By Alfred W. Porter, B.Sc.

Mechanical Analogue of a Diffraction Grating.

In the *Astrophysical Journal* for July Mr. H. M. Reese describes an experiment in illustration of the performance of diffraction gratings. "The scheme was to produce, on the surface of mercury, ripples emanating from a series of equidistant points distributed along a straight line." To produce these a thin sheet of iron was cut into the form of a comb of sixteen teeth, spaced 5 mm. apart, and attached to the lower prong of an electrically-driven tuning-fork arranged to vibrate in a vertical plane. This comb was set near the edge of a tray of mercury in such a way that the teeth would dip into the surface. When the ripples were examined stroboscopically it was seen that near the comb they mixed together chaotically; but at a moderate distance they resolved themselves into several series of regular rectilinear wave-trains, which advance in different directions and are symmetrically distributed. These correspond to the spectrum of zero order moving out in a direction normal to the comb—and spectra of orders one and two on each side. An image of the ripples can be projected on a screen. To do this most successfully it must be arranged so that the projecting lens receives as much light as possible from the source. This is brought about if a converging beam from a lantern is incident upon the mercury and the projecting lens is placed at the point of convergence of this beam after reflection.

Distribution of Radiation from Radioactive Sources.

The sun appears as bright near the middle as near the edge; so does a round hot poker. This is a consequence of the cosine law, which states that the radiation from any very small element of the luminous body varies according to the cosine of the angle between the normal to the surface and the direction in which the element is viewed. The reason the element does not radiate equally in all directions is that the radiation comes not from the surface only, but from a perceptible depth; and in oblique directions the radiation suffers most loss from absorption by the layer of substance through which it passes. If it came only from the surface there is no reason why it should not spread out equally in all directions, and in that case the sun would not appear of uniform brightness. Prof. Rutherford has recently (*Philosophical Magazine*, August, 1906), explained in this way the peculiar appearance of the image formed by the alpha stream from radioactive bodies. A wire is made radioactive by exposure to radium emanation. The alpha radiation from it is allowed to pass in vacuo through a very narrow slit to a photographic plate, where it makes what is essentially a "pin-hole" photograph. Now the action on the plate is most intense near the edges of this image. This effect is attributed by Rutherford to the extreme thinness of the radioactive layer taken in conjunction with the fact that the alpha particles are, on an average, projected equally in all directions. Various corroborative experiments have been made. A brass rod of square cross section is made radioactive and examined either photographically or by its action upon a screen of willemite. If the screen is placed parallel to one of the faces of the rod the appearance is that of a feebly luminous band of about the same width as the rod, bordered on each side by a more luminous region. The central region is made luminous by only one side of the rod, while the outer regions are affected by two sides. When examined photographically the edges of the central band are very sharply defined without any gradual transition of intensity from one region to the other. Still more complicated appearances are obtained by the use of a rod of hexagonal section. A sudden change of intensity occurs at every point where the tangential radiation from another side of the rod adds its effect.

Formulae for Combinations of Lenses.

In a paper on lens testing read before the Optical Convention by Mr. T. H. Blakesley the following simple formulæ for lens combinations are given:—

1. If light passes through two lenses whose focal lengths are f_1, f_2 respectively, and the distance between the second principal focus of the first lens and the first principal focus of the second lens is K, *measured positively along the axis in the direction in which light is travelling*, then the resulting focal length of the combination is $f_1^2 \div K$.

2. The first principal focus of the combination is found by moving from the first principal focus of the first lens a distance $f_1^2 \div K$ in a direction opposed to the direction of light.

3. A similar motion $f_2^2 \div K$ takes place in the second principal focus, but in this case the motion, if positive, is down the stream of light.

4. If an object is in the first principal focus of a lens whose focal length is f_1 and a second lens whose focal length is f_2 is applied to the issuing light, *at any distance from the first lens*, the magnification of the resulting image is constant and its value is $-f_2/f_1$.

In applying these principles a thin concave lens has a *positive* focal length, a thin convex lens a *negative focal length*. The magnification is negative when the image is inverted. The lenses are supposed to be coaxial.

Although these formulæ follow at once from well-known principles, they are probably not as generally known as they deserve to be.

ZOOLOGICAL.

By R. Lydekker.

Winter Whitening of Hair.

As his observations have recently been called in question, it is interesting to note that Professor E. Metchnikoff, in a communication published in the *Comptes Rendus* of the Paris Academy for the present year (Vol. CXLII., pp. 1024, *et seq.*), reiterates the statement that the winter whitening of hairs (as well as feathers) is due to the action of a particular kind of phagocytes, or chromophagous cells, which remove the pigment from the interior of the hairs or feathers to the skin or to the surface. The theory that gas is the bleaching agent will, in the Professor's opinion, not hold good. Mr. Metchnikoff's observations have been made on the hair of the variable hare, and on the feathers of willow-grouse, ptarmigan, and of a hen, whose plumage began to turn white; and the chromophagous cells are stated to have been actually seen at work.

The Russian Tarpan.

In a communication published in the *Proceedings* of the Royal Society of Edinburgh, Professor Ewart expresses the opinion that the now extinct tarpan, or wild horse of the Russian steppes, was not a distinct species or race, but a hybrid produced from the mingling of the Mongolian wild horse with certain other ponies. He also ventures on the conjecture that the "Celtic pony" will probably prove more distinct from the horse than is either the zebra or the ass.

The Eye of the Mole-Rat.

If additional evidence in favour of the evolution of animals be necessary it would be afforded by the observations of an Hungarian anatomist, on the eye of the great mole-rat (*Spalax typhlus*) of Eastern Europe and Egypt, a creature which has the general habits of a mole, but is a strict vegetarian. Although the eye is completely buried beneath the skin (which probably permits the passage of a certain amount of light), and is thus functionless, yet all the essential structural features of that wonderful organ are present—only they never develop beyond the initial stages.

The Multiplication of Generic Names.

As an instance of the complexity now being introduced into zoological classification by advanced specialists, it may be noted that the well-known American naturalist, Mr. G. S. Miller, has recently proposed no less than twelve new genera of bats, all based on species which had previously been referred to other genera. The same writer is also of opinion that the Philippine flying-lemur, or colugo, should be separated generically from the ordinary Malay species. For the former, he adopts Gray's name, *Colugo*, while for the latter, on account of priority, he would employ the name *Cynocephalus* (long applied to the African baboons), for the familiar and time-honoured *Galeopithecus*. This change involves the replacement of the family name *Galeopithecidæ* by *Colugidæ*. It will be curious to see how naturalists, other than specialists, follow this lead.

The Habits of Elephant-Seals.

In an account of the zoological collections brought home from South Georgia, Dr. Einar Lönnberg gives some interesting particulars with regard to the habits of that gigantic animal, the elephant-seal, or sea-elephant. When disturbed by man, these monsters, if much irritated, raise themselves on the pelvic region, with the greater part of the body in an upright position, and at the same time inflate their nostrils, open their mouths, and roar hideously. At such times they are dangerous to approach directly in front, although they are at the same time so heavy and clumsy that an active man, if standing a little to one side, can escape their attack without much difficulty. Contrary to the general belief, they use only the fore-flippers when moving on land. Although the old males are generally silent, the young bulls keep up a constant howling during the spring, which has been compared to the barking of dogs.

Origin of Domesticated Fowls.

In *Spolia Zeylanica* for July (of which the Editor has been favoured with a copy) some interesting information is given with regard to hybridisation experiments between the Ceylon jungle-fowl and ordinary fowls. It is well known that such hybrids can be produced, but since in the one case at that time recorded such hybrids were infertile *inter se*, Darwin was led to exclude the wild Ceylon bird from the ancestry of domesticated fowls. In the new experiments, by mating hybrid cocks with domesticated hens, fertile eggs have been produced, as they also have by crossing a hybrid cock with a $\frac{3}{4}$ domestic hen. Hybrid cocks crossed with hybrid hens have, however, hitherto failed to produce fertile eggs.

REVIEWS OF BOOKS.

ASTRONOMY.

Royal Astronomical Society of Canada: Transactions for 1905, including selected papers and proceedings (Toronto, 1906, 209 pp.).—The contents of this volume, extracted from the year's work of an obviously vigorous and flourishing society, cover a wide range, from American-Indian stellar legends to the new Dominion Observatory at Ottawa and the latest Pacific cable, and from the astronomy of Tennyson to the figure of the sun. The disappointing eclipse expedition to Labrador is much in evidence, partly on account of elaborate experimental preparations for coronal photography, and partly on account of the actual expedition and the geographical, magnetic and meteorological results which were beyond the reach of weather conditions. We can recommend both the volume and the Society as being worthy of a wider support than it has yet met with outside the limits of the Dominion.

BOTANY.

British Flowering Plants, by W. F. Kirby (Sidney Appelton: 1906).—We fear that both the beginner and the scientific botanist will find this book inadequate. It has one good feature, in describing the caterpillars which feed on various plants; and interesting scraps of plant lore are occasionally thrown in. But it is difficult to identify some of the figures. Scarce plants, such as *Geranium pyrenaicum* or *Rubus chamaemorus*, pose as typical of a genus; others, as *Cytisus capitatus*, *Trapa natans*, *Erica herbacea*, *Cerinthe major*, *Globularia vulgaris*, and *Oleaster*, are not found wild in the British Isles. There are also serious omissions. From a stroll in a Surrey lane we brought in *Melilot*, Ploughman's *Spikenard*, *Lysimachia vulgaris*, and *Torilis anthriscus*, neither of which could we find in this volume.

E. S. G.

GEOLOGY.

Annual Report of the Smithsonian Institution (Washington, Government Printing Office, 1906, 714 pp. and index).—The report which has just been issued brings the record of the "Operations, Expenditure, and Condition of the Institution" down to June 30, 1904. It is replete with information which is interesting to the whole scientific world. It is furnished with 208 illustrations, including geological specimens, sections, maps, and portraits. It is divided into two parts, the first dealing with matters referred to in the report of the Assistant Secretary of the Institution, and the second including papers describing and illustrating collections in the U.S. National Museum. Part I. gives an account which will be useful to young geologists, of the founding and history of the Institution. An Act of Congress founded it in 1846, and a museum was made one of its principal features. The first collection to come into its possession, was the valuable mineralogical cabinet bequeathed to it by John Smithson, who was himself a Fellow of the Royal Society of London. As years passed on it came to be regarded as the legitimate repository for national collections, and grants were made by Congress for its upkeep. Then in 1880, it was enacted that the collections made by the Coast and Interior Survey, the Geological Survey, and other Government bodies, should be permanently housed in what had come to be the National Museum. The Museum, we are told, contains objects whose intrinsic value mounts into the hundreds of thousands of dollars, many of which are so small that several could be carried away in a man's pocket, and, consequently, like all scientific institutions, it constantly needs an increased income and increased staff to protect its treasures. We must pass over the interesting reports by the Head Curators of the Departments of Anthropology, Biology, and Geology, and refer here to the Bibliography for 1903-1904. In this we have not only the titles of various publications issued, dealing with specimens in the Museum, but each has a brief, but sufficient *résumé* of important points. By far the greater portion of the volume is taken up with "Contributions to the History of American Geology," by George P. Merrill, the Head Curator of Geology. No less than 400 pages are devoted to historical narratives of the founders of geology in the States, as well as of others who are still living. In Great Britain we can scarcely imagine such a great service being done with Government aid in a Government publication, and it remained for Sir A. Geikie to do something in the same direction in his "Founders of Geology," without aid from the State. The names of all the best-known American geologists are to be found in this historical review, together with some account of the work of each, and in most cases a portrait, some of which are full-page, illustrates the text. This portion cannot fail to be of great benefit to current geology. The science has grown up around certain names, and some of them are best known by the errors which they committed. Herein lies the educational value of such a record, and the U.S. Government is doing a good work for future geologists in honouring past geologists by a permanent and official record of those whose work is done. Here we find details of the lives of many whose names are already familiar on this side of the ocean, and the accounts which are given now enable one to feel more in touch than ever with the pioneers of the science in the New World. Amongst those whose life-histories are given are Silliman, Eaton, Hitchcock, Mather, Owen, Dana, Dawson, Powell, and Logan, names as well known as any of our British geologists. In Appendix B, there are brief biographical sketches of the principal workers in American geology. This includes many whose work has been dealt with at greater length in a former part, but adds a large number of names of other geologists who have done, and are doing, good work. This part will be of great value for future reference. Three chapters deserve special mention, dealing respectively with the Footprints of the Connecticut Valley, the Eozoon Question, and the Laramie Question. These are of international importance, and are treated at length. The rise of the belief in the animal nature of the *Eozoon Canadense*, and its dramatic downfall, should be read by all who have a lingering belief in the foraminiferal nature of the remains. Possibly the matter would not have received the attention which the whole scientific world gave to it, if it had not been backed by such energetic men as Logan, its discoverer, and Dawson, the Canadian geologist, and Principal of McGill University, Montreal, for 38 years. From 1863, when Logan first announced his discovery, until 1894, when, as we are told, J. W. Gregory and H. J. Johnston-Lavis gave the "death-blow to the theory," warfare raged around the *Eozoon*. Dawson died in 1899, and it could have been but a few months before his death that he made, in person, a last appeal to the London Geological Society, and exhibited his specimens and lantern slides, illustrating the various points on which he depended for proving its animal nature. The appeal was, however, to a new and unsympathetic generation, to whom it had been satisfactorily proved that the structure was a purely mineralogical simulation of the organic. In summing up, we are told that "there is apparently no doubt but that this simulative form is due merely to a process of chemical metamorphism, a process of indefinite substitution and replacement, technically metasomatosis, acting upon rocks which are granular aggregates of lime-magnesian pyroxenes, with more or less calcareous matter, the serpentine being in all cases secondary. Similar structures have, moreover, been noted by various observers in rocks which were unmistakably of igneous origin." This conclusion should be noted in all geological text-books that still mention the *Eozoon*, although we think that this reputed creature might well now drop out entirely. The Laramie beds first examined by Hayden in 1854 and 1855, along the Upper Missouri River, have received almost as much discussion as that through which the *Eozoon* passed, although with more satisfactory results. The difficulty very early presented itself of deciding as between Cretaceous and Eocene. Cope, in 1874, said that in his opinion, there was "no alternative but to accept the results that a Tertiary flora was contemporaneous with a Cretaceous fauna, establishing an uninterrupted succession of life across what is generally regarded as one of the greatest breaks in geological time." And in 1897, Drs. Knowlton and Stanton came to the conclusion that "the base of the Laramie they would place immediately above the highest marine Cretaceous beds of the Rocky Mountains region," the top being marked by the Fort Union beds. The Fort Union beds are now, in fact, regarded as Eocene, and the lower-lying as Laramie Cretaceous.

E. A. M.

MISCELLANEOUS.

Carcinoma of the Rectum, by F. Swinford-Edwards, F.R.C.S. (Ballière, Tindall and Cox; price 2s. 6d. nett). Mr. Swinford-Edwards gives here his experience on the diagnosis and treatment of the above disease in words that should impress on his professional brethren the value of its early recognition and the necessity for prompt operative measures. In a few pages Mr. Edwards writes instructively on his subject, and presents it in a concise and up-to-date manner. Had the author illustrated his small work, it would, to our mind, have enhanced its value in the eyes of the student and practitioner.

MICROSCOPY

Conducted by F. Shillington Scales, B.A., F.R.M.S.

The Staining of Blood Films.

The *British Medical Journal* gives a summary of a comparative study by Alphonse Huisman of the value of different methods which have been recommended for the staining of blood films. He has tried seventeen different formulæ, following the directions given by their different authors, but finds that, with the exception of Jenner's stain, they do not readily yield good results, and often involve a long and complicated technique. With Jenner's method he is always able to obtain satisfactory preparations, but he thinks he can improve upon it by the introduction of certain modifications of his own. The stain he uses is a mixture of equal parts of a 1.175 per cent. solution of solid azure blue in absolute methyl alcohol and a 0.825 per cent. solution of pure eosin BA (Hochst) in the same medium. He stains for two minutes without previously fixing the film. By this method the nuclei appear a violet-blue, whilst the basophile protoplasm takes a light blue stain which gives a good differentiation from the rest of the preparation. The red corpuscles are rose-coloured. The neutrophile granules are rose-violet, violet, or violet-blue; basophile granules are blue, the metachromatic basophile granules are violet-red, and the oxyphile granules are red. The author also observes that some of the lymphocytes exhibit, when stained by this formula, evidence of a fine, blue, or metachromatic granulation.

Mounting Protozoa.

Very little attention is given in most text-books to methods of mounting Protozoa, either temporarily for the purpose of study or permanently. A brief account of some suitable methods, based on a contribution by Mr. C. W. Hargitt, may accordingly be of some service. With regard to living specimens, in the case of Amœba, or the more or less sedentary Protozoa, little precaution in the way of supporting the cover-glass, or rendering the specimens quiescent, is necessary. But for Paramœcium, Stylonichia, and others of similar activity, some method of restricting their movements is desirable. Narcotics, such as chloral hydrate, cocaine, and nicotine, or gelatinous substances, are apt to set up pathological conditions sooner or later. A few shreds of absorbent cotton under the cover-glass, so tangled as to greatly limit the movements, have proved very satisfactory, without interfering with the vitality of the specimens, and fresh water can be easily added without fear of losing the specimen.

Intra-vitam staining may be satisfactorily done with many of the Protozoa, and with many stains, especially methylene blue, methylene green, methylene violet, &c., in very dilute solutions. These stains are used to differentiate the organism during life, and must be watched throughout accordingly.

For killing and fixing, a rapid re-agent is necessary in order that the least possible distortion may result. This can be done by the method of irrigation under the cover-glass—the most difficult, but the least likely to lose the specimen—or by placing all the specimens bodily in the re-agent. Lang's fluid, used hot, applied to the edge of the cover-glass and drawn in with blotting paper applied to the other edge, is one of the most suitable fluids for the irrigation method. It must be removed by washing out with water in a similar way. The stains must be applied also, their excess removed, dehydration by alcohols of increasing strength will follow, and finally Canada balsam must be drawn in by similar methods.

Killing by heating over a lamp or burner, as is done with bacteria, is quite useless.

Perhaps the best method, when the supply of material permits of it, is to pipette the infusoria into a large watch-glass, carefully draw off the surplus fluid with a finer pipette, if necessary, under a microscope or lens, and to finish withdrawal of the last few drops by a thread syphon. The killing may be done by means of a saturated solution of mercury perchloride, to which has been added one per cent. acetic acid. This makes an excellent killing fluid, though weak chromic acid, 2 per cent. osmic acid, and potassium iodide have also their advocates. Formalin is generally rather unsatisfactory. Certain organisms, however, such as the Vorticellidæ, prove very difficult to kill in an expanded condition, and recourse must, therefore, be had to some narcotizing method, such as the gradual addition of chloral hydrate, &c.

When fixed, the organisms may be washed in water or dilute alcohol, as required, stained by one of the usual methods, dehydrated, cleared with cedar oil, clove oil, &c., and mounted in balsam. Glycerine or glycerine jelly, of course, requires a modified process. With each stage of the operations similar precautions must be adopted in transferring from one medium to another as were used in transferring from water to the killing medium. By the foregoing methods beautiful and permanent mounts may be made of Amœba, Paramœcium, Volvox, &c., in all their life stages.

Mounting Small Insects.

An excellent method for mounting small insects and Coleoptera was given some time ago by Mr. E L. Fulmer as follows:—Drop the specimens into absolute alcohol and leave for an hour or more to dehydrate; then transfer to xylol or other clearing agent for a few minutes, and then mount direct in balsam. If it is desired to make opaque objects transparent, they should be boiled for a moment in caustic potash and then treated as above described. If it is desired to clear and mount small and fragile specimens with little handling, this may be accomplished by dropping them in water-free carbolic acid to kill, dehydrate, and clear. After remaining in this an hour or more they are mounted in balsam.

The smaller beetles, after being chloroformed, are often mounted directly in balsam. They are cloudy for a time when mounted in this manner, but in the course of four or five weeks they become clear, so that this simple method may be used to advantage with small insects and their parts if they are given time to clear up perfectly before being studied.

In working with scale-insects (Coccidæ), the insects are first picked out of the scales and placed upon a slide where it is desired to mount them. A few drops of a 5 per cent. solution of caustic potash are applied, and the specimens boiled in this for two or three minutes by holding the slide over a Bunsen burner. The specimens are then washed two or three times by being covered with a few drops of absolute alcohol, after which they are cleared and balsam applied.

Parallel Light in Photo-micrography.

An inquiry from a correspondent in Melbourne, Australia, raises a point in illumination for photomicrography which puzzles many people and is worth my answering in detail. If a well-corrected stand condenser is adjusted so as to give parallel light, a well-corrected sub-stage condenser will then give an image of the source of illumination upon the screen, if the sub-stage condenser is focussed on the object on the slide and the objective correctly focussed likewise. Using the Nernst incandescent filament a narrow streak corresponding to the very narrow filament will be visable, whilst the edge of a lamp-wick would give a correspondingly broad streak. Any statements that are met with in text-books as to obtaining a fully-illuminated field with parallel light by this means are doubtless based on practical experience and are due to the fact that ordinary stand condensers are so ill-corrected that a perfect representation of the image is not obtainable. For visual work nothing better than this streak could be wished for; the streak image, ugly as it appears to the uninitiated, being the only really critical form of illumination for all critical work, for, after all, it is only a small part of the field that the worker is actually investigating, and for this he must have the utmost possible degree of resolution and definition. In photo-micrography, however, such a streak would be unpleasant, and, therefore, resolution must be sacrificed slightly for the sake of even illumination. To do this either the sub-stage condenser must be thrown very slightly out of focus, or the stand condenser must be re-adjusted. My own method is to use the stand condenser to focus the source of light in the air about eight inches from the sub-stage condenser, and in this position I place an iris diaphragm. The sub-stage condenser is then focussed on this iris diaphragm, and consequently on the image of the source of illumination. A very slight adjustment to the sub-stage condenser will then give me a bar of critical light, or enable me to fill the field uniformly, just as if I were focussing directly on the lamp. But it is only the very best sub-stage and stand condensers that will do this, and of the latter I know of no other condenser than Mr. Conrady's which is sufficiently well corrected.

Having adjusted the stand condenser for parallel light, on looking directly at it an image of the source of illumination will be seen because the eye itself is able to bring to a focus parallel rays. But if the condenser be unable to form truly parallel rays, it will be seen to be filled with light. That such parallel rays are not formed by ordinary condensers is readily demonstrated by endeavouring to adjust the stand condenser so that on bringing a sheet of paper nearer and removing it further the disc of light upon it remains of the same diameter, as it should do if the light were really parallel. The articles on photo-micrography which I contributed to these columns from November, 1905, to June, 1906, inclusive, will probably be found of service on this and similar points.

New Micro-chemical Tests for Wood.

The Journal of the Royal Microscopical Society gives the following summary of some new micro-chemical tests for wood, by V. Graefe. He adds to a solution of vanillin some drops of isobutyl-alcohol, and lets a little sulphuric acid (sp. gr. 1.84) run down the side of the test-tube. After heating, the mixture turns dark red, with a shade of blue. On diluting with alcohol and repeated additions of acid, it changes through blue-green to pale green. The author recommends as a standard re-agent the following:—30 c.cm. isobutyl-alcohol *plus* 15 c.cm. sulphuric acid. When wood-mash is treated with this re-agent the wood turns black; if now diluted with a little alcohol and the test-tube be shaken, the wood turns blue or blue-green, whilst the fluid becomes red-violet. Sections of ligneous tissue treated with this fluid are at first red-violet and after a time blue. The sections should remain in the re-agent for about an hour and then be mounted in glycerine. Apparently the stain is not very permanent. A mixture of isobutyl-alcohol and sulphuric acid also forms a useful re-agent. A drop of the mixture placed on a micro-section gradually turns it red, and if, after the lapse of about an hour, it be placed in glycerine it assumes a wine-red or red-violet hue.

Quekett Microscopical Club.

A series of demonstrations on the practical use of the microscope and its accessories has been arranged for the ensuing session. The first will be given by H. F. Angus on November 16, on "Axial Sub-stage Illumination," embracing the use of the plane and concave mirrors, sub-stage condensers, methods of centring the illuminant, and critical illumination. Subsequent demonstrations will deal with sub-stage non-axial illumination, including oblique, dark-ground, and multi-colour illumination, the employment of polarising apparatus, illumination of opaque objects, the use of various pieces of apparatus for recording observations, &c. Arrangements are not yet completed, but a full programme will be available shortly. The demonstrations will be given on the third Friday in each month from 7 till 8 p.m., and will not interfere with, but will be in addition to, the ordinary meetings of the Club, which are held at 20, Hanover Square, W., on the third Friday in each month at 8 p.m. precisely. Gentlemen interested are invited to communicate with the Hon. Sec., A. Earland, 31, Denmark Street, Watford, Herts.

Microscopical Lectures.

The Manchester Microscopical Society has sent me the prospectus of its Extension Lectures for the forthcoming winter, and I am glad to again call attention to so excellent a scheme. The prospectus contains a list of fifty-three lectures by various members of the Society on almost all subjects coming within the range of the microscope, many with titles no less attractive than the subjects of the lectures, and all illustrated by lantern slides, specimens, microscopes, or drawings. The object of the extension scheme, now in its ninth year, is, as the prospectus states, "to bring scientific knowledge, in a popular form, before societies who are unable to pay large fees to professional lecturers," and this is done without other charge than that of travelling expenses and hire of slides, save where lectures are given before societies which are commercial undertakings, or are subsidised from public grants. These lectures must be of great value in the populous working-class districts of Manchester and its neighbourhood, and reflect both credit and honour on the energetic society which is responsible for them, and, as I have said before, it would be well if other societies would follow so excellent an example. They would themselves benefit much by coming in contact with a wider public than that of their own membership.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road Cambridge.*]

The Face of the Sky for October.

By A. FOWLER, F.R.A.S., AND W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.0 and sets at 5.39; on the 31st he rises at 6.52 and sets at 4.36.

The position of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Oct. 3 ..	26° 18′ E	6° 33′	244 19′
„ 8 ..	26 29′ E	6° 15′	178 20′
„ 13 ..	26° 28′ E	5 55′	113 23′
„ 18 ..	26° 17′ E	5 32′	46 27′
„ 23 ..	25 54′ E	5° 6′	340 30′
„ 28 ..	25° 20′ E	4 38′	274 34′
Nov. 2 ..	24 33′ E	4 8′	208 38′

THE MOON:—

Date.	Phases	H. M.
Oct. 2 ..	○ Full Moon	0 48 p.m.
„ 10 ..	☾ Last Quarter	3 39 p.m.
„ 17 ..	● New Moon	10 43 p.m.
„ 24 ..	First Quarter	1 59 p.m.
Nov. 1 ..	Full Moon	4 46 a.m.
Oct. 7 ..	Apogee	7 48 p.m.
„ 19 ..	Perigee	5 48 p.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible before midnight at Greenwich, during the month:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.
			p.m.		p.m.	
Oct. 2	26 Ceti	6·0	11 28	356°	12 0	308°
„ 5	B.D.+12° 473 ..	6·2	9 55	96°	10 55	220°
„ 6	B.D.+14° 657 ..	6·5	7 48	116	8 28	211°
„ 23	B.A.C. 6671 ..	6·5	8 35	158°	8 49	183°
„ 25	ι Capricorni ..	4·3	6 49	348°	6 56	338°
„ 26	45 Aquarii ..	6·3	8 16	48°	9 29	266°

THE PLANETS.—Mercury (Oct. 1, R.A. $12^h\ 49^m$; Dec. S. 4° 24′; Oct. 31, R.A. $15^h\ 42^m$; Dec. S. 22° 7′) is an evening star throughout the month, but sets so soon after the Sun that he may be considered unobservable.

Venus (Oct. 1, R.A. $15^h\ 10^m$; Dec. S. 22° 32′; Oct. 31, R.A. $16^h\ 44^m$; Dec. S. 27° 48′) remains an evening star, but, in consequence of the great southerly declination can only be observed for a short time after sunset; the planet in fact sets about one hour after the sun throughout the month. The distance of the planet from the earth is rapidly diminishing, and the apparent diameter accordingly increases from 28″·4 on the 1st to 44″·8 on the 31st. The crescent phase is now presented to the observer, one-third of the disc being illuminated on the 15th. The greatest brilliancy of the planet as seen from the earth occurs on the 26th.

Mars (Oct. 1, R.A. $10^h\ 55^m$; Dec. N. 8° 11′; Oct. 31, R.A. $12^h\ 5^m$; Dec. N. 0° 47′) is a morning star rising about 3.30 a.m. throughout the month. With its small apparent diameter of about 4″, it is of little telescopic interest.

Jupiter (Oct. 1, R.A. $6^h\ 42^m$; Dec. N. 22° 50′; Oct. 31, R.A. $6^h\ 48^m$; Dec. N. 22° 47′) is coming into a more favourable position for observation, rising at 9.50 p.m. on the 1st, and at 7.58 p.m. on the 31st. The planet describes a short direct path between ε and ζ Geminorum until the 29th, when he is "stationary." The apparent diameter of the planet increases from 36″·0 to 39″·4 during the month.

Saturn (Oct. 1, R.A. $22^h\ 48^m$; Dec. S. 9° 51′; Oct. 31, R.A. $22^h\ 43^m$; Dec. S. 10° 18′) is favourably placed for observation in the evening, being on the meridian at 10.9 p.m. on the 1st, and at 8.7 p.m. on the 31st. The planet describes a short retrograde path a little to the South of λ Aquarii. The outer major and minor axes of the ring system are respectively 43″ and 4″·6, so that in small telescopes the ring appears almost as a straight line; the "disappearance" of the ring is due next year.

Uranus (Oct. 15, R.A. $18^h\ 21^m$; Dec. S. 23° 41′), remains in Sagittarius, but is not very favourably situated for observation, as it sets soon after 9 p.m. at the beginning of the month, and at about 7.30 p.m. at the end of the month.

Neptune (Oct. 15, R.A. $6^h\ 55^m$; Dec. N. 21° 57′), rises shortly after 9 p.m. and crosses the meridian at 5.19 a.m. at the middle of the month. The planet is about 1½ degrees North-West of ζ Geminorum, is in quadrature on the 6th, and stationary on the 16th.

METEORS.—The principal meteor showers during the month is that having its radiant point near ν Orionis, and hence known as the Orionids. The maximum is from the 18th to the 20th, and the meteors are described as swift with streaks. The radiant point is in R.A. 92° Dec. N. 15°.

Algol presents conveniently observable minima on the 3rd at 9.19 p.m., 23rd at 11.2 p.m., and 26th at 7.51 p.m.

TELESCOPIC OBJECTS:—

Double stars: γ Arietis $1^h\ 48^m$, N. 18° 48′, mags. 4·2, 4·4; separation 8″·8. Easy double, power 30: notable as being the first double star observed telescopically.

γ Andromedæ $1^h\ 58^m$, N. 41° 51′, mags. 2·1, 4·9, separation 10″·2. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a binary, the components of which are now less than 1″ apart.

NEBULÆ:—

Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedæ. Seen with a 3 or 4 inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.

(32 M.) Nebula close to the great Andromeda nebula, and situated about 2° to the South. It is fairly round, and appears somewhat like a star out of focus.

(18 H.) Lies about the same distance north of the great Andromeda nebula that 32 M does south; it is faint, but large and elliptical.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

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A Novel Use of König Flames.

By Our Berlin Correspondent.

If gas be allowed to enter through a tube into a capsule closed by a membrane, and to issue through another tube, its speed of escaping will be altered by any vibration imparted to the membrane, and if the flame be lighted at the end of the tube its height will accordingly be dependent on these vibrations. This is what is known by the phenomenon of the flames of König. To demonstrate the presence of vibrations in the flame, a rotary mirror or a stroboscopical device is generally used, the latter enabling the shape of the oscillating flames to be investigated more closely. If the form and frequency of these vibrations have to be fixed by an objective record, they are photographed on a tape of paper unwinding in front of them. Mr. K. Marbe* has been engaged, in the course of his researches in the range of the Psychology of Language, in recording the oscillations of such flames by a method which is simpler and less expensive than photography. A tape of paper is unwound for this purpose at right angles to the diameter of a sooty flame, and the flame leaves on the pap r soot spots corresponding to the shape of the oscillations.

A tuning fork of 300 vibrations was installed on a wooden box, open on one side, and having on the other a circular hole to which the capsule was fitted, the membrane lying immediately above the opening (Fig. 1). A horizontal roller, carrying a paper tape, was arranged at some centimetres above the point of the flame; and the tape was unwound at a convenient speed. As long as the tuning fork was kept at rest, a simple strip of grey colour was obtained. As soon, however, as the tuning fork was set into vibration, this record, as seen from Fig. 3, changed character, showing tongues pointing in the direction of motion of the tape. These tongues seem to be the image of part of the luminous sheath of the flame.

The author succeeded in transmitting the vibrations of a telephone membrane to a König flame, and in registering them according to the process thus described, replacing the membrane by the telephone membrane, which was set vibrating by the alternating current from

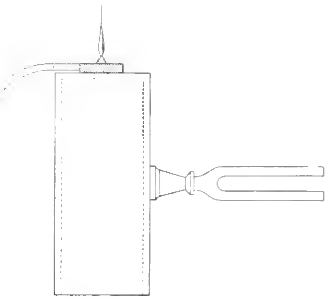


Fig. 1.

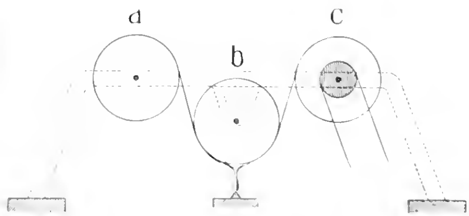


Fig. 2.

Apparatus for producing smoke records by a König flame. (1) Flame and resonating box. (2) Tape for smoke record.

the municipal mains. Figure 4 shows the results thus obtained. He, moreover, ascertained the frequency of this current by the aid of two flames connected to the telephone membrane and to the tuning fork respectively.

The idea then presented itself of transmitting the human voice to the membrane, and of trying to fix it graphically according to the same method, the membrane being connected in the ordinary manner to a

* *Physikalische Zeitschrift*, No. 15, 1906.

Smoke Records of a König Flame.

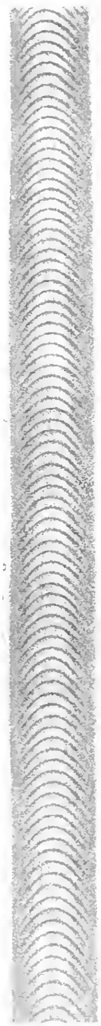


Fig. 3.—Tuning Fork Vibrations.

Fig. 4.—Telephone Vibrations.

Fig. 5.—Vibrations produced by Vowel Sound "ah."

Fig. 6.—Vibrations o Vowel Sound "a."

Fig. 7.—Vibrations of Sound "an."

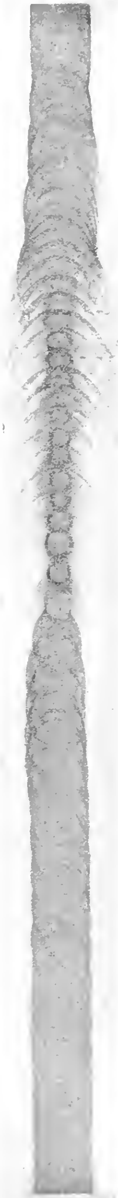


Fig. 8 Vibrations of Sound "fang."

microphone. The characteristic images of the vowels a, e (German) are reproduced in Figures 5 and 6, in which the whole vibrations will be accurately ascertained. The same process, moreover, as seen from Figures 7 and 8, allows whole words to be analysed. Mr. Marbe's process seems to be destined to give rise to interesting discoveries in the range of acoustics as well as of phonetics. The author is at present engaged in constructing an apparatus enabling the pictures of such sounds as make up a continuous speech to be recorded graphically. This apparatus is to be combined with a counting device, marking on the tape tenths of a second, and is to be used in connection with statistical research work on the tune of human speech, researches which constituted the starting point of the present investigation. It may be said that their interest will be the higher, as no means of obtaining repeated and extensive records of human language has been so far forthcoming.

The Flora of the Presidency of Bombay.

THIS local flora, intended as a supplement to Hooker's "Flora of British India," should have been completed in January last by the issue of the sixth part; but Dr. Cooke, C.I.E., who has been engaged on the work at Kew for the past five years, has found as it progressed that the number of plants requiring description has constantly increased, and application has been made to the Secretary of State for India, who is subsidising the publication, for permission to exceed the limits originally laid down. Two additional parts have been sanctioned, and the complete work will not be issued until 1908. Part six is now in the press; the five that have already appeared have received many expressions of approbation from botanical experts, and from the non-scientists, revenue and district officers, and others, for whose use the book is designed.

The only existing regional flora is that by Dalzell and Gibson; this was published in 1861, and is now very incomplete, the knowledge of the vegetation of the Presidency having been added to so largely by the work of the Botanical Survey of India during the past fifteen years. The new flora will meet a want widely felt by all whose duties make it advisable that they should be acquainted with the characters and properties of the plants of the province.

It has long been the desire of Dr. Cooke to compile this manual, for which he had gathered much valuable information while acting as Honorary Director of the western branch of the Botanical Survey. He was for twenty-eight years Principal of the College of Science at Poona, and on his retirement in 1893, the Government of Bombay, acting on the recommendation of Sir George King, the Director of the Survey, wished then to entrust him with the work, but Lord Kimberley, the Secretary of State, vetoed the proposal, and it was not until 1901 that official sanction was given for its preparation. As the flora has been completed, the large private herbarium, formed by Dr. Cooke while in charge of the Survey in Bombay, has been made over by him to the Poona herbarium, to replace the loss by fire of the Government collection there in May, 1902.

World Weather.

By SIR JOHN ELIOT, K.C.I.E., F.R.S.

THE Meteorological Office has recently issued a memoir entitled "The Life History of Surface Air Currents: A Study of the Surface Trajectories of Moving Air."* It gives the results of the investigations of Dr. Shaw, Director of the Meteorological Office, and Mr. Lempfort, his scientific assistant. The research marks an important advance in the scientific work of the office, and suggests that in future improvement in the practical work of forecasting will be based on the results of scientific investigation rather than on empirical or experimental inferences. It is, however, of special importance as it employs novel methods for the investigation of air movement on the large scale—which are leading to results not merely unexpected, but opposed to the fundamental principles which have formed the chief stock-in-trade of meteorologists during the past fifty years.

The most important principle hitherto utilised by meteorologists is that connecting pressure of gravity forces and air movement. It is usually stated in the form that air invariably moves from positions of higher pressure to those of lower pressure (the pressure being reduced to sea-level equivalents). In the other form (a development of the pressure) air is assumed to move along planes of equal pressure, inclined to the horizontal, or from positions of higher to lower level, and hence under the action of gravity. In addition to these laws and modifying their application is the principle first largely utilised by Farrel, that air moving on the rotating earth is always being deflected to the right of its path by a force or amount depending on its velocity and latitude position on the earth's surface, but *not* on the direction of the movement. It is apparently assumed that air never moves from positions of lower to higher pressure, or from positions of lower to higher level. This is certainly, more especially in the latter case, opposed to ordinary dynamical principles and experience. For example, the bob of a pendulum moves for one half of its period of a single oscillation from higher to lower level under the force of gravity, and during the second half from lower to higher level with respect to the horizontal plane. Similarly, if the actual air motion be assumed to take place along an isobaric plane it follows that it may not only move down the plane from higher to lower level (acquiring momentum and kinetic energy), but also if it possesses momentum it may move in the opposite direction from lower to higher level (losing kinetic energy). Similar arguments might be applied to the pressure principle. The preceding remarks are simply intended to show that if ordinary dynamical (not hydrodynamical) principles are applied to meteorological investigation, their limited application in the form usually adopted by meteorologists is apparently neither valid nor justified by dynamical methods. Meteorological problems are chiefly problems of air movement, as changes of temperature, and humidity, rainfall, &c., are primarily the results of air movement. Hence the necessity for the study of the phenomena of air movement, from theory as well as from observation.

Air movement on the large scale may be that of the permanent or periodic circulations (as, for example, the trade winds and monsoon winds), and that of anticyclonic or cyclonic conditions, more or less temporary

* "The Life History of Surface Air Currents: A Study of the Surface Trajectories of Moving Air," by W. W. Shaw, Sc.D., F.R.S. (Director, Meteorological Office), and R. G. K. Lempfort, M.A. Published by the authority of the Meteorological Committee. (Wyman & Sons, H.M. Stationery Office, 1906; price, 7s. 6d.).

in character, and in their most acute form, termed in ordinary language, "storms." The chief features of the first class of air movements have been determined both from observation and theory. The movement undoubtedly depends upon large temperature differences between the equatorial and polar regions, or between sea and land areas. With respect to the air movement in cyclones and anti-cyclones there is, on the other hand, much diversity of opinion. Meteorologists, for example, differ as to the conditions necessary for the initiation and development of cyclonic storms, the transformations of energy which occur during the storms, and also of the actual features of the air movement. Farrel, on the whole, the most distinguished American meteorologist, resolves the air movement of a cyclonic system into circular movement about a moving centre on a rotating surface. On this assumption he explains the incurvature of the winds and the contrast of the intensity of movement in different quadrants of the storm. The initiation of cyclonic storms is ascribed by him to temperature differences, and he classifies them into storms with a central warm area, and with a central cold area. The leading German meteorologists, we believe, now hold that cyclonic storms are mere incidents in the larger atmospheric circulations, just as a whirl in a stream of running water, is a mere eddy in the general stream movement, and due to some slight local obstruction or other cause.

With respect to the diversity of opinion on this point, Dr. Shaw, in his memoir, remarks: "I think I am justified in saying that meteorologists are even not quite clear as to whether the circulation of a revolving storm as shown on weather maps is the primary element of the problem, the *fons et origo malorum*, or is merely an exaggerated bye-product of more general atmospheric currents, possibly in the upper regions, just as the eddy or the whirlpool is the bye-product of the flowing stream and its boundaries." Dr. Shaw's criticism of the vague and careless employment of meteorological terms by meteorologists generally is both just and deserved. In connection with his investigation he especially instances the use of the terms barometric minimum and movement of a barometric minimum, pointing out that they are used to designate phenomena of different orders, and hence to suggest similarity when there is no similarity. It is, on the one hand, universally admitted that pressure is never absolutely uniform over any large area, and that it is in a state of constant flux or change by amounts differing from place to place due to a variety of actions, of which one is the movement of storm areas or barometric minima of a definite type. It is, for example, possible in a hot country like India for pressure on one day to be lowest in, say, Sind, on the next day in North-Eastern India, and on the following day in Burma or the Deccan. Weather charts drawn for short intervals of, say, one hour, might indicate the gradual transference of the seat of lowest pressure from Sind to Chola Nagpur and the Deccan. But to treat this apparent transfer by the same methods and subject to the same general laws as the movement of the centre of an intense cyclone is absurd, as it assumes similarity of conditions and actions where no such similarity exists. The changes of pressure accompanying the advance of cyclonic storms appear to be mainly due to internal actions, whereas in the other class of barometric minima referred to they are chiefly the result of external actions. Hence, to employ Dr. Shaw's words, "Treating the apparent displacement of all barometric minima generally in the same manner tends to obscure rather than to elucidate the difficult problems associated with the origin and march of storms."

How far this confusion taints the results of many meteorological investigations can only be surmised. It is, however, certain that more exact definitions and methods of investigation are essential for the progress of the science of meteorology. Assuming that there are cyclonic storms having a definite continuous existence and associated with certain peculiarities of air movement, the investigation of the motion of the air masses within the storm area or passing through it is evidently a problem of the greatest importance. Hitherto, chiefly due to the almost exclusive study of daily weather charts, little or nothing has been done to trace the continuous movement of the air masses affected by the cyclonic storm. The movement of the centre of the storm or of the isobars or the direction of the winds in relation to the position of the centre with respect to that of the position of observation, have hence been carefully studied from the charts, but these results tell us nothing of the previous or future history of the actual air mass passing over the place of observation, and hence throw little or no light on the conditions which determine the changes of temperature, humidity, and rainfall at the place of observation. Meteorologists are now agreed that what are called circular storms are not circular in the proper sense of the word. There is not merely a flow of air round, but also convergence towards a central area. There is also a large upflow over and near the central area, and also an outflow above and a descent probably in the outskirts of the storm area. The motion is hence successively complicated. It is also very variable, as squalls and gusts of the most violent character may alternate with strong but less destructive winds. Also in the cyclonic storms of the temperate regions of the northern hemisphere, the winds in the same quadrant of cyclonic storm, and hence from the same general direction, differ largely in their meteorological character (that is, temperature, &c.). These differences are, as Dr. Shaw has now shown, due to the previous history of the particular air mass in the given position of the storm in question. Hence the value and importance of Dr. Shaw's investigations.

The chief method of investigation employed is simple, but requires almost continuous registration of the air movement at a large number of stations in the area passed over by the storm. This is possible in the British Islands, as self-recording anemographs are in operation at many places. The path of a given mass of air is worked out from their observations by a step-by-step method. The following gives a statement of the method by means of a particular case. Suppose at a place the 8 a.m. observation shows that 20 miles of wind from W.S.W. has passed over it during the previous two hours. Half of this is assumed to indicate the movement of a mass of air during the previous hour (7 a.m. to 8 a.m.), and the remainder the movement of the same mass from 8 a.m. to 9 a.m. Suppose, then, an instrument observing at the new position shows that during the two hours preceding 10 a.m. 24 miles of wind from S.W. has passed over it. It is then assumed that the previous mass of air will have moved 12 miles from S.W. to N.E. between 9 a.m. and 10 a.m., and the same amount from 10 a.m. to 11 a.m. These values are plotted on a chart, and inferences from similar observations from noon onwards are made. The broken line thus obtained will give an approximation to the motion at the earth's surface of a definite air mass. The paths thus obtained are termed "trajectories" by Dr. Shaw. The method is undoubtedly only approximate, and subject to limitations. So far as we can judge, its employment is legitimate, and the conclusions thence established by Dr. Shaw and Mr. Lempfort are valid.

They have worked out a large number of trajectories for each of a series of typical storms which have passed over the British Islands in recent years, and formulated inferences of great interest and importance respecting the movement of air into or out of storm areas. The following gives a brief summary of what appears to us to be the most important of these conclusions :—(1) In travelling storms, while in the front portion there is motion of the air from higher pressure to lower pressure, associated with falling temperature and with the gradual development of cloud and rainfall, there is also in the rear, sometimes from points quite near to the centre, motion of air from lower pressure to higher pressure and higher temperature with improving weather, and again there are instances of motion with practically no change of pressure, temperature, or weather. Over the Atlantic, air moves generally from higher pressure to lower pressure, but sometimes from lower pressure to higher pressure. There are also instances of air moving for long distances with little or no change of pressure. (2) An essential difference must be drawn between fast travelling storms (as estimated by the ratio of the velocity of the centre to the speed of the wind) and slow travelling storms. The former take all their air for the part which is represented by circular isobars from the region on the right hand or southern side of the path in the front of the storm and throw out an approximately equivalent amount on the same side in the rear. A slow travelling storm makes use of air from both sides of its path. That from the right hand or southern side flows directly towards the central portion, while that from the northern side curls round the rear of the storm. This difference in the characteristics of the two types cannot be accounted for by regarding all approximately circular storms as revolving vortices of air carried along by currents of different velocities. (3) In travelling storms the veering of wind is not generally a uniform sequence. Winds from some of the directions are relatively transient; on the other hand, winds from other directions are relatively persistent during the passage of the storm, even at considerable distances from the centre; the transition from the one persistent direction to the other is comparatively sudden. In fast travelling storms the directions of the more persistent winds are S. or S.W. and N.W., while in the case of slow travelling storms the more persistent winds are E. to N.E. and S.W. to S. (4) On the eastern side of the Atlantic, surface air currents from the south are generally short lived, and soon disappear in the central portions of cyclonic depressions. Only in fast travelling storms do southerly currents continue beyond the path of the centre and describe loops round the centre. (5) Air currents from other directions than the south are much longer lived. They persist until either (*a*) they reach the trade winds, or (*b*) turn round the rear of a depression and approach the centre from the southward, or (*c*) join a depression over the Western Atlantic. (6) The rainfall incidental to travelling storms can be, generally speaking, related to the ascent of air from the surface, as indicated by the convergence of the air, deduced from its motion, in a region not far distant from the locality of the rainfall, generally to the south or south-east of it. (7) The regions of high pressure that intervene between depressions and travel with them may be called anticyclones when we are dealing with a chart for a restricted area, but they are to be distinguished from the well-defined anticyclones which are persistent for days together. These latter are for the most part inert and comparatively isolated masses of air, taking little part in the circulation which goes on around them. (8) The motion of air with reference to the moving centre of a cyclonic depression is not, as a rule, properly described as circular motion round the position of minimum pressure, modified by incurvature, and transformed into spiral motion about a moving centre. The description would apply to the motion of air in the case of certain currents commencing on the northern side of a slow travelling storm, but the following cases of motion also occur: (*a*) in approximately straight lines leading towards the minimum or a point on its path in front, or on the trough line of a V-shaped depression, (*b*) round the minimum in curves, to which the minimum stands rather in the relation of the focus of a conic than that of the centre of a circle.

Space does not permit us to discuss to what extent these conclusions, if valid, will modify the body of conclusions known as "the laws of storms," and hence the methods and practice of forecasting in the English Meteorological Office. In conclusion we congratulate the Meteorological Office on the results of the investigation. It is an example of the importance of research based on scientific methods which is now essential to further large progress in the improvement of the practical work of weather forecasting.

The Carriers of Plague.

"Pulex Cheopis."

So long has plague in India been associated with rats that there is a proverb to the effect that "when the rats begin to fall from the roof, it is time for people to leave the houses." The Indian rat falls from the ceiling cloths and mud roofs of the Indian go-downs and bungalows and huts because it is a house rat and not a sewer rat like the English variety; and, consequently, the incidence of an epizootic of plague among rats in India is usually marked by the deaths of numbers of them in and about the walls and ceilings. And generally this appearance of plague among the rats is followed by the appearance of plague among human beings. But though there seemed thus an immense probability that plague among rats was transmitted to human beings, there has been great difficulty in proving it, and the difficulty lay in fixing on the means of transmission. This difficulty has been disposed of by the investigations of the latest scientific commission, which was appointed by the Indian Government, and which is still pursuing its work. So important are the results of its first year's inevstigations, and so decisive are they, that they have been published as an interim report in the "Journal of Hygiene." They establish definitely the fact that the chief carrier of plague from rat to rat, and from rat to man, is the rat flea "Pulex cheopis."

The commission, instituted by the Indian Government, at the instance of Dr. Martin, F.R.S., Director of the Lister Institute, comprised Major Lamb and Captain Liston, of the Indian Medical Service, Dr. Petrie and Mr. Sydney Rowland, of the Lister Institute, and several Indian investigators of plague, Mr. Kasava Pai among them, lent by various Indian States. The commission had to set about its work from the beginning, and unprejudiced by the conflicting experiences and theories of preceding investigators. For, although evidence in support of the connection between plague among rats and plague among human beings has accumulated since the discovery of the plague bacillus by Yersin and Kitasato, there have been many negative results in the attempt to demonstrate the belief positively. Most of the observers who have studied the question on the spot—Yersin, Ogata, Simond, Thompson, Koch, and Gaffky—have arrived at the opinion that from an epidemiological point of view plague is to be regarded as a rat disease in which human beings may participate. The relationship of the epizootic among rats and the epidemic among human beings has been particularly studied with great care for the outbreaks in

Sydney by Ashburton Thompson (1902, 1903, 1904); in Port Elizabeth by Blackmore (1902); in Hong Kong by Hunter (1904); as well as in Cape Colony by Mitchell (1906); in Queensland by Baxter-Tyrie (1905); and for Calcutta by Pearse (1905). In India the connection was scientifically indicated, if not established, by Snow and Weir (1897), Hawkin (1898), and the German commission (1899). But as late as the report of the last Indian Plague Commission (1903) no definite conclusion was reached as to the share which rats take in disseminating plague. (The introductory preface in commenting on the contradictory nature of the evidence, remarked that it was not clear whether rats contracted the disease after its appearance among the human community, or whether they introduced it, or even whether it was shared by human being and rat alike.)

There have been similar difficulties in determining how the infection was conveyed from rats to human beings, or from rats to rats. One way of conveying the infection would arise from the cannibal practice which rats betray of eating one another's dead carcasses. But it has been shown that a very large amount of plague-infected carcass absorbed in this way is necessary in order to contract plague, and in any case man would not contract the disease in this way. That insects were the carriers of infection occurred to several investigators. Yersin (1894), Hawkin (1897), Nuttall (1897), Ogata (1897), and Simond (1898) examined flies, ants, fleas, and bugs, and found plague bacilli in their bodies, but though Simond succeeded in conveying plague from rat to rat by means of fleas, there were a number of unsuccessful experiments, and this want of success was recorded by Nuttall and Tidswell, and by the German Plague Commission, and by others who believed in this method of transmission. A few theorists objected to the hypothesis on other grounds; the chief of which was that the rat-flea was indigenous to the rat, and would not bite human beings or other animals. These objections have been finally disposed of by the identification of the characteristic rat-flea as "Pulex cheopis," and by the proof that it will, and does, bite other animals.

We shall make the process of proof most clear by recording briefly the results of the experiments made by the Plague Commission. (1) It was first shown by confining rats in separate wire boxes, so that they could not come into physical contact, that plague could none the less spread from a plague-infected rat to a healthy rat. (2) It was shown that plague might be conveyed to guinea pigs in the same way. (3) On the other hand, close contact of plague-infected animals with healthy animals did not give rise to an epidemic (epizootic) among the healthy animals if fleas were excluded. Nor did plague-infected animals, if the same principle of exclusion was observed, convey the disease to the young they were suckling. (4) When, however, fleas were admitted to the colony of animals the epidemic, once started, spreads from animal to animal, the rate of progress being in direct proportion to the number of fleas present. (Special precautions eliminated the possibility of air-borne infection in these experiments.)

That plague can be conveyed from animal to animal by means of the rat-flea was thus shown, together with a presumption that this was the principal means of conveyance. This presumption is strengthened by other experiments. It is shown both directly and indirectly that in a plague-infected house the infection may be due to the presence therein of rat-fleas, which are capable of transmitting the disease to animals. The direct proof was obtained by allowing guinea pigs to run free in plague houses which had been previously disinfected, but in which there were still fleas—as was shown by their subsequent discovery on the guinea pigs. The guinea pigs contracted plague, and the fleas caught on them were found capable of conveying plague to healthy animals. When guinea pigs, placed in a plague house, were isolated in gauze covered cages in such a way that fleas could not reach them, the guinea pigs did not contract plague. If in a cage where they could be reached by fleas, the guinea pigs died in several cases. The microscopic examination of the fleas which the guinea pigs attracted in plague houses revealed the presence of the plague bacillus in their intestines.

One indirect testimony to the superior effectiveness of the flea as a vehicle of plague was afforded by the experiments made with regard to the infectivity of plague localities on the floors and walls of plague houses—irrespective of the presence of fleas. The plague bacillus disappeared from floors and walls much more quickly than had been thought probable. It remains to record the possibility that other insects besides fleas may convey the infection, and a suggestion (noted in the preface to the report) that plague may be a disease of fleas.

Alcohol as a Stimulus to Life.

In the second number of *Science Progress* (John Murray) the place of honour is given to an extremely lucid and suggestive article by Mr. W. B. Hardy, F.R.S., of Caius College, Cambridge, in which he treats of "The Physical Basis of Life" from the point of view of the structure of atoms. In the course of the article he refers to the various experiments of Messrs. Maupas, Calkin, and Woodworth in estimating and prolonging the number of generations of the tiny organism *Paramoecium caudatum*. Normally the vital impulse of this organism dies out after the 170th generation, but Woodworth succeeded in prolonging its existence to the 800th generation by supplying it with appropriate stimulant. The stimulant tried on the Paramœcia with most success was—alcohol! "It was added to the water in which the animals lived, so that they were always immersed in one part of spirit in 5,000 to 10,000 of water"—an experience resembling in a diluted form that of the Duke of Clarence's adventure in a butt of Malmsey. In the effect produced there was the touch of Nature which makes the whole world kin. The periods of depression were wiped out. The curve of vitality no longer showed the ominous recurrent falls. At the same time the rate of growth and division, that is to say, the physiological activity, was increased by as much as 30 per cent. Something of the same effect was produced by strychnine, but there was a remarkable difference in the fundamental action of the two drugs, for whereas the beneficial effect of alcohol endured after the drug ceased to be administered, that of strychnine did not. Alcohol exacted no "physiological usury," in spite of the prodigiously increased rate of living. It was beneficial in its after effects. Other articles of importance in *Science Progress* are "Some World's Weather Problems," by Dr. W. J. S. Lockyer; the "Origin of Gymnosperms," by Mr. Newell Arber, and "The Igneous Rocks," by Dr. J. W. Evans.

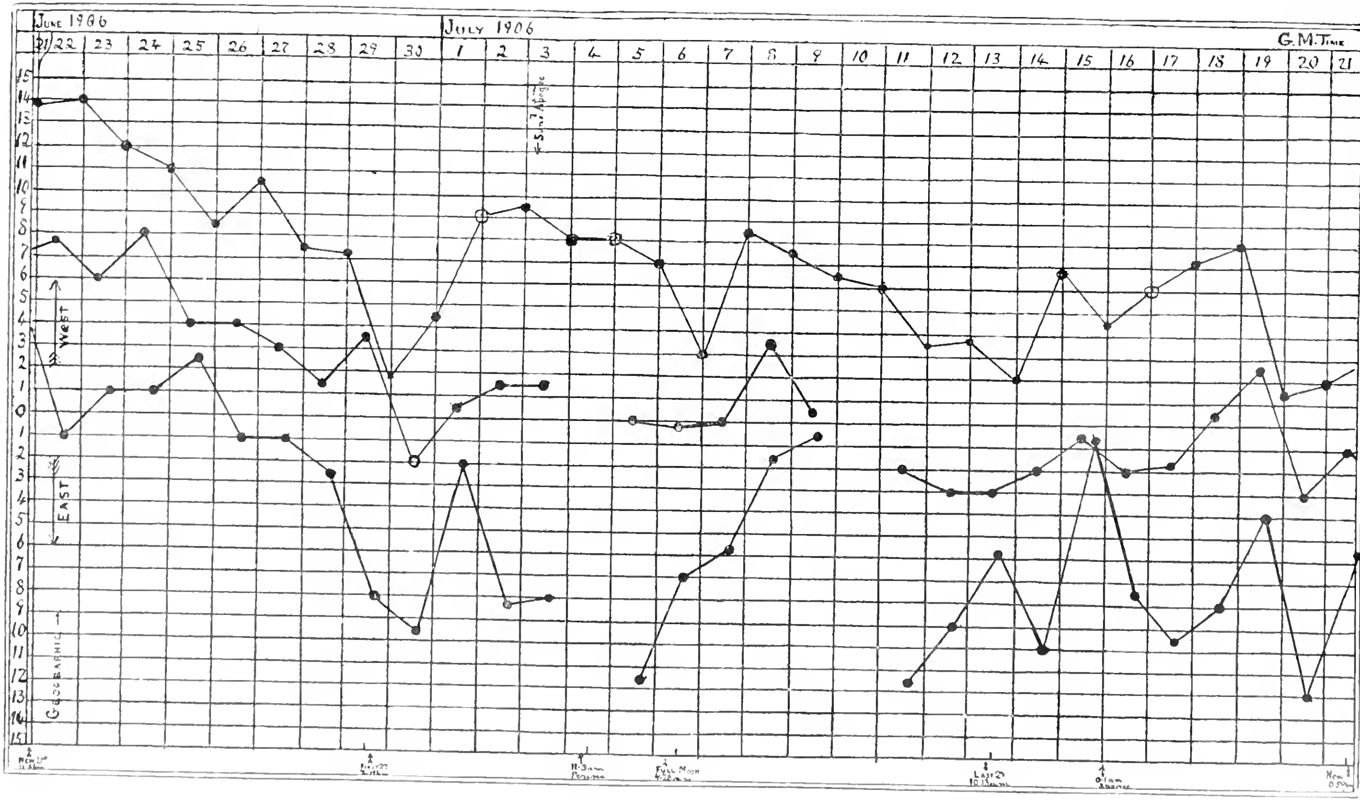
Messrs. F. Darton and Co., the well-known manufacturing opticians and scientific instrument makers, were awarded a Grand Prix and Diplôme d'Honneur at the Milan Exhibition for their manufactures.

Lunisolar Variations of Gravity.

By W. H. Sharp.

Specimen Chart for one Lunar Month, extracted from Charts of Diurnal Electric Tidal Variations of Gravity, as exhibited by the movements of a ball of lead at the end of a brass tube, freely supported as a "Sharp's Pendulum" (*vide* "Knowledge," October, 1906), in a room about 10 ft. × 9 ft. × 9 ft. capacity, situate in 0° 3′ E. Long., 51° 32′ 40″ N. Lat.

The original readings were taken direct from a tangent scale of millimetres, which is here represented as four times enlarged. Only the means of the oscillations observed at midnights, noons, and minima respectively are here shown, by dots as in three series—upper, middle, and lower. The lines connecting the dots have no connection with this record, except as links showing sequence. The four light dots are interpolated from contiguous means in the day curves. The black dots represent direct mean readings.



Earthquakes.*

By CAMILLE FLAMMARION.

THE alarming eruption of Vesuvius was hardly over than the world was aghast at the earthquake of San Francisco. The Italian volcanic eruption lasted from the 5th to the 12th April; and the North American earthquake began, at 5.13 on April 18, with a violent trembling of the earth in vertical, horizontal, and oblique oscillations, and, as we know, it caused the overthrow in the course of two or three minutes of the greater part of the "Queen of the Pacific," and it was followed by an immense fire. Four hundred deaths were the consequence, and the financial loss was computed at four hundred millions of dollars. This disastrous shock was followed by several others, notably that of the 20th April, and the 19th May.

California has always been subject to earthquakes. In a list of the seismic disturbances in California, Professor Holden reports as many as 514 in the whole State, 254 being in the territory of San Francisco alone, and this only from 1850 to 1886. During the nineteenth century there have been ten serious shocks, and in 1868 a part of the town was destroyed.

The towns and villages on the zone of maximum of intensity were cruelly affected for the length of 180 miles (290 kilometres), from Santa Rosa to Salinas.

The last eruption of Vesuvius and the earthquake of San Francisco, following the earthquake of Calabria, which continued from the 8th to the 15th September last, the one in India on the 4th April, so replete with terrible consequences, and the many slight shocks observed everywhere, lead us to study these phenomena of nature by the help of the most recent investigations of science. The planet which we inhabit does not possess the apparent stability which it presents to the mind uninstructed by history and science. The intensity of seismic shocks and the elasticity of the terrestrial globe was seen in the great disaster of Assam. This earthquake, which was not less disastrous than that at Lisbon in 1755, took place on the 12th June, 1897, and the tremors of the earth not only spread from this spot to the antipodes, but they were registered again on the seismographical apparatus of India, after having twice made the tour of the globe, like the atmospherical and marine waves caused by the gigantic explosion of Krakatoa in 1883, which I showed in my special work on the subject.

The earthquake at San Francisco seems to have been of the same intensity and energy as those of Lisbon and Assam. It was registered by all the seismometers of the globe, and it was not till they had twice made the tour of the world that the tremors decreased in force. I have before me the diagrams of the oscillations in England (Birmingham), Belgium (the Royal Observatory of Uccle), Austria (Laibach, etc.), and they show the course of this wave. It passed Birmingham at 1.25, by Greenwich time. As the time of 5.13 at San Francisco corresponds to that of 1.13 at Birmingham, we see that it only took twelve minutes to go from San Francisco to Birmingham. It arrived at the same time at Brussels (Uccle), and a little later in Austria, where the apparatus registered an oscillation lasting from 2.30 to 3.30. The time of Central Europe is in advance of Greenwich time. Mr. Davison's study of the oscillations of Birmingham showed that a second registration followed the first in 3 hours 13 minutes, *after having made the tour of the whole world.*

If to the 40,000 kilometres, which represent the tour of the world, we add the 9,000 kilometres which separate Birmingham from San Francisco, we see that the first impulsion was powerful enough to cause a vibration which resounded at least to the distance of 50,000 kilometres.

The vibrations produced by the earthquakes are transmitted at a different rate of speed through the entire mass of our planet to that with which they pass along the external crust.

On the 2nd February, the seismometer of the Observatory of Florence registered a disturbance 9,000 kilometres off; and on that day a submarine volcanic eruption and a tidal wave destroyed the town of Buenoventura, a port of Columbia, on the Pacific Coast. I also stated, on the 7th March, that the central meteorological bureau of Vienna, in Austria, registered on the night of the 18th-19th February, an earthquake 12,000 kilometres off, which proved to be the violent shocks at Martinique, Saint Domingo, Saint Lucie, and a part of the Antilles, and the recrudescent activity of the mountains of Peleus.

The shocks at San Francisco were remarkable for their length and their rotary character. The violent phase lasted forty seconds, but it was three minutes and a-half before their registration was concluded by the apparatus of the Naval Observatory of Mare Island. Before their destruction, it was noticed that many houses had left the straight line. A whole street rose up like a wave several metres long. In Calabria and elsewhere, deep, open crevices were made by these dislocations.

Earthquakes vary as much in the distance of their effect as in the intensity. Some, like those of Lisbon in 1755, or Assam in 1892, are felt two or three million square kilometres away, and others do not vibrate further than a hundred or ten square kilometres. In 1879, the inhabitants of Linthal, in Glaris, were thrown out of their beds, whilst fifteen kilometres from there nobody felt it. It has been generally supposed that earthquakes are the consequence of volcanic eruptions. This idea is evidently erroneous, and nowhere is it more proved to be wrong than in Japan.

Everybody knows that Japan is *par excellence* the land for earthquakes, as it has as many as three or four a day. But the most unstable regions are not by any means those contiguous to Fusiyama, the great Japanese volcanic mountain, which, moreover, has been quiet for the last three hundred years. No eruptive manifestation accompanied the great seismic disturbances of 1891 and 1897, but many earthquakes have taken place in regions not at all volcanic. At San Francisco, for example, there is no volcano; and there have been earthquakes in many other spots where the volcano is absent or where, if it exists, it has shown no activity. Seismic disturbances are not caused by volcanic eruptions, either near or distant. But the seismic disturbances and volcanic eruptions are both due to the pliant state of some region of the earth's crust.

Seismic disturbances are always in the neighbourhood of mountains. The most prolific regions are those of a steep decline. The regions of a slight decline are those which, at 200 kilometres from the sea, have only a slope of from five or ten degrees; and places where, at the same distance from the seashore, there is a steep descent exceeding three degrees. All the regions which are incontestably seismic have a fall of three

* Translated by Rachel Challice (Member of the Astronomical Society of France).

to five degrees, particularly in Japan. Seismic centres abound especially where there are such contrasts as a steep submarine strata, terminating in a very abrupt terrestrial slope. There are constant disturbances along the crevasses. There is a shrinkage of the crust along the dislocations, and they provide, as it were, a safety valve for internal disturbances. In other words, the volcano and the earthquake are brothers and not father and son, as it has been thought for a long time in default of sufficient observation.

The secular cooling has induced folds and hollows of solidified external crust on the pulpy shell, which goes on contracting, so that these noises are not only rumblings, but they are accompanied by movements; for the enormous pressure from the interior induces upheavals and volcanos. Heat, hot water, and steam, are all at work; ruptures of equilibrium are accompanied by puffs of elastic gas, showing the existence under our feet of a considerable tension, which is always ready for action.

Chains of mountains and maritime slopes result from the gradual cooling of the globe, the cracking of the crust, which, being forced to a base, descend more or less. These cracks cannot occur without some disturbances; and, as I said before, they occur constantly every day and every hour. We only notice the most violent ones, which bring disaster to us. But, as a matter of fact, earthquakes are regular and normal episodes in the life of our planet.

The new science of seismology has been created by statistics, agglomeration and classification of the documents. Alexis Peirey, a learned compatriot and colleague of the Academy of Dijon, made a catalogue of the thousands and thousands of shocks mentioned everywhere from 1844 to 1872. I tried to continue this catalogue in my review, *Astronomy*, from 1883 to 1888, with the help of my laborious colleague, C. Detaille. But these statistics took up so much room that we had to give them up. It has been continued for several years, with scrupulous and indefatigable care, by M. de Montessus, of Ballore, in the excellent Belgian review, *Ciel et Terre*. This mass of documents records more than 170,000 earthquakes, which give room for the study of seismological geography. According to the general synthesis of M. de Montessus, of Ballore, which embraces the whole world, it is seen that the terrestrial crust trembles nearly equally, and almost solely along the two narrow zones which cross at an angle of 67 degrees, the Mediterranean or Alpine Caucasian and the circum-Pacific circles. These two zones coincide with the two most important lines of the terrestrial surface. Earthquakes are common on the most mobile strips of the terrestrial surface, where great accumulations made have been dislocated and raised in the tertiary period, before the formation of the principal actual chains.

Birkbeck College. The Rt. Hon. R. B. Haldane, M.P., distributed the prizes at the Birkbeck College, on Friday, October 26, and lectures have been delivered during the past month by Professor Flinders Petrie, Mr. S. L. Bensusan, and Professor H. Von Herkomer, R.A. Among the other lecturers of the present term are Mr. Hilaire Belloc, M.P., Dr. James Cantlie, Mr. E. Thompson Seton; and next term lectures by Mr. E. T. Reed, of *Punch*, Miss Gertrude Bacon, and Dr. J. D. McClure, F.R.A.S., are promised. The summary of examination results shows that in the past year fourteen Birkbeck College students passed the London B.Sc. (six with honours), and five the B.A. final; twenty-eight the Intermediate Science, and seven the Intermediate Arts.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Photography of the Infra-Red.—M. G. Millochau describes in the *Comptes Rendus* (1906, cxlii. 1407, and cxliii., 108), the method he is employing for photographing the infra-red and mapping this part of the solar spectrum. He follows on the lines adopted by M. Stefánik, who, by the use of coloured screens to absorb the more easily visible parts of the spectrum, finds that he can get the extreme violet (H and K) to appear very brilliant, and can easily see to about λ3830 (L), which is as far as some glass instruments transmit, and can similarly extend the visibility of the spectrum in the infra-red. M. Millochau uses a deeply-coloured alcoholic solution of chrysoidine, malachite green, and aniline violet to cut off the light other than the extreme and infra-red. The plates used are first exposed to diffused light to fog them, advantage being taken of the fact that the light at the red end of the spectrum reverses or negatives the ordinary exposure effect. But as the reversing action has been found to be little more that superficial, it is advantageous to stain the film and so prevent the preliminary exposure effect from penetrating so deeply as it otherwise would. The preparation of the plates in actual practice is as follows:—Lumière's Σ plates are soaked in water for fifteen minutes, then soaked in a well-filtered, saturated alcoholic solution of either chrysoidine, or erythrosine, or (less advantageously) eosine, rapidly rinsed, and dried. The preliminary exposure follows, artificial light being used, but further details of it are not given. By this means M. Millochau has mapped the solar spectrum from λ8377 to λ9325.

Reversal by Red Light.—It is interesting to note that the reversing action of the extreme red and infra-red rays, as mentioned in the previous paragraph, is almost superficial, as this is evidence in favour of the supposition that the air has something to do with the reversal, and that perhaps it is due to oxidation, a theory that has been suggested by several observers, especially Abney. But all exposure effects begin at the surface that the light impinges upon, and one would like some proof, in this particular case, that the infra-red light really has had time to work through or well into the gelatine film, so that the superficial character of the reversal is not due merely to a want of penetrating power of the light. In this connection may be noted the recent observation of Messrs. Precht and Stenger, that reversal by over-exposure is retarded by treating the plate with a 1 per cent. solution of a developing agent before exposure, a plate so treated requiring more than forty times the exposure it previously needed to produce reversal; as well as the much older experiments of Abney, in the similar use of reducing agents, and the exclusion of air. But in forming a theory as to the action of light in producing reversal effects, it is not sufficient, as one is so often tempted to do, to consider experiments of one kind only, however conclusive they may appear to be. A theory of reversal naturally includes, or is a part of, the theory of the character of the thing reversed, that is the developable image, and this is a large subject. Reversal, as well as the developable condition, appears to be producible by any form of energy, but it has been found that the reversibility of the developable image depends upon the method by which the developable condition has been produced, as well as the method by which the action is supplemented in order to get reversal. These observations are referred to more at length in this Journal for August, 1904, and seem difficult, if not impossible, to reconcile with the theory that so many are satisfied with at the present day, namely, that the changes are simply chemical, the developable image consisting of a reduction product of the silver bromide, and reversal being a process of oxidation.

Smoking Sensitive Paper for Recording Instruments.—Referring to the method of using sensitive paper in self-recording instruments that I described two months ago, Mr. Thomas Bolas, in the *Amateur Photographer*, says that: "The operation of smoking the paper is an extremely delicate one, but when done successfully the film of carbon is uniform, grainless even under a high power microscope, without tendency to scale off, and so thin as to give a bare line or tracing without roughness. In smoking paper it must be held by two opposite edges, so as to stretch the sheet on a metal surface, this surface being a portion of a cylinder. A broad-wicked paraffin lamp may be used for smoking, or, better still, a number of small pieces of camphor laid in a row and lighted."

Photographing Medals, Coins, etc.—The well-known similarity between the representation of a sunk and a raised design is taken advantage of by M. E. Demole (*Comptes Rendus*, 1906, cxlii., 1409), in the photography of such things as medals. An impression of the article is obtained in dull lead foil, and the concave side of this is photographed under oblique illumination directly on to bromide paper, without the use of an intervening negative, the double lateral reversal giving an unreversed print. The details of the operation are not further described.

Picture Post-Cards.—The postal facilities accorded to "picture post-cards" are equally available for any form of pictorial or graphical communication, so that the methods of making them may sometimes be of practical scientific interest. Seeing that a good card is made by sticking together a number of sheets of paper, it seems to me a great waste of time and trouble to treat the card as a whole, that is, to first stick the sheets together and then sensitise, expose, develop, and finish the photograph on the card, when the photographic work would be more quickly and advantageously done on the outer sheet of paper before it was stuck to the others to form the card. For the photographic sheet, ordinary bromide or other printing paper might be used, and when the "picture" is completed it might be made into a card by sticking the necessary paper sheets at the back of it. The paper bearing the photograph and the other sheets that go to make up the card should all be rather larger than required, and the whole finally trimmed to size. I do not know whether trade printers of picture post-cards adopt this method, but it appears to offer many advantages.

A Long-Lost Beetle.

Non equidem invideo, miror magis.

One day in September last four persons might have been seen on a Surrey common, turning up spadefuls of the heath-clad sand, and scrutinising them with eager eyes and fingers. "Treasure seekers," said the passers by, and they were right; but we were prospecting after no vulgar treasure. Three of us, it should be said, were amateurs, the fourth was an insectarian of note.

Two hundred years ago, the great Sir Hans Sloane discovered on Hampstead Heath, and added to the British fauna, a strange beetle, captured parasitic in a nest of the "Bloody Ant" (*Formica sanguinea*). It was duly chronicled, described, exhibited at a meeting of the lately founded Royal Society, and received the name of *Lomechusa strumosa*. It may be seen to-day in the museum, side by side with a second specimen unaccountably taken soon afterwards in the Mail Coach between Gloucester and Cheltenham. This was in 1710; until now no third example had been noted; it came to be looked upon as dubious or extinct, and has long been omitted from the published lists of British species.

Towards the end of July in this year, the long-lost insect was re-discovered by an enthusiastic coleopterist, and it was under his guidance that we were rummaging the clods. He failed on this occasion to unearth *Lomechusa*; but he showed us several mounted specimens from the former find, and we were rewarded by meeting with another extraordinarily rare beetle, resembling a tiny crocodile, and known as *Dinarda dentata*. The "Bloody Ant" nests in old fir-stumps, or burrows into banks, concealing its nest with grass. It is a slave holder, carrying off in their pupa state, and training to obedient servitude, the young of *Formica fusca*. *Lomechusa* is fed by its hosts; they obtain from it, in turn, a sweet secretion, which deteriorates the nursing instincts of the workers, causing pseudogynes, or false queens. It is constant to *F. sanguinea*, being never found in nests of the adjacent large "Wood Ant," *Formica rufa*.

To a humanistic student, the genus specialist is not less interesting than are to himself the prizes of his own research. Our friend, we found, was not a naturalist, not an entomologist, not even a coleopterist, all our general questions as to Hampton Court spiders, male wasps, death watches, he smilingly put by. Of beetles inhabiting ants' nests, and of their entertainers, he knows what is to be known, and lives in hopes of knowing more; all other knowledge he shuts out. Some day, I suppose, this micromania will exhaust itself; there will be no tiny worlds to conquer, no more quiddities to reveal; we shall admire, instead of classifying, shall once more see Nature whole, shall revert for the poetry, the power, the picturesqueness of zoology, to the pages of a Buffon, a Linnæus, a Gilbert White.

W. M. T.

The "Unilens."

The short account in the last number of "Knowledge" of the "Unilens" has elicited a good deal of comment. This correspondence is in accord with my preliminary experiences. When first this simple idea occurred to me I went to consult several opticians. But all said at once that the use of one lens as a telescope was impossible. I took a specimen into a certain shop and explained that the arrangement acted most satisfactorily, at all events as regarded my own eyesight. But the proprietor was obdurate, and merely said "That will never do." "But look for yourself," I urged, holding the instrument before him. Yet he would not even condescend to look through it, saying, "You *must* have a second lens near the eye before it can be any good," and I came away leaving him absolutely unconvinced. Now some letters have been sent to "Knowledge," of which two are by recognised authorities on optics. One correspondent, dating from the Athenæum Club, says: "A person with normal vision . . . . cannot, with the 'Unilens' focus anything that is more than two or three feet beyond the glass. In order to obtain a sharp image of an object beyond that distance, he must render himself artificially hypermetropic, by usi[ng] as an eyeglass a concave lens . . . . " and adds: "[illegible] the inventor finds the instrument as practically useful [as] your note suggests that he does without an eyeglass, the inference is that he has at least two dioptres of hypermetropia, of which possibly he is unaware." An oculist writes: "You say that it is always in focus; now, I submit that the rays of light, being convergent, are *never* in focus for an emmetropic person. The very definition of an emmetrope indicates this one in whose eyes, without accommodation, parallel rays are focussed on the retina."

Well, what is my answer? I find that nearly everyone to whom I have shown the instrument (I can only recall five exceptions) can see clearly through it, and find it useful for magnifying distant objects. Are we, then, to understand that all these people have "at least two dioptres of hypermetropia?" If so, despite its long name, I think it is a very convenient malady to suffer from.

Mr. Wentworth Sturgeon, on the other hand, writes to say that his father many years ago introduced a closely similar instrument. It is but natural that so simple a device should have often been tried before, and though I had never heard of its being previously adopted, I do not claim any originality in the appliance beyond the details of its present form.

B. BADEN-POWELL.

Ancient Mazer in Epworth Church.

An early example of the Mazer is religiously preserved among the old communion plate in the parish church of Epworth. It was originally a wassail-bowl and was presented to the church by Duke Thomas, one of the great family of Mowbrays, who resided in the castle silver-parcel gilt. The rim of silver is ten inches in diameter. The religious device engraved on a large silver button in its centre has the Holy Family surrounded by a moulding ornamented with rays of glory and the figures of St. John the Baptist and St. Andrew with St. Andrew's cross.

A special interest will always attach to the old communion plate of this church as having been so many

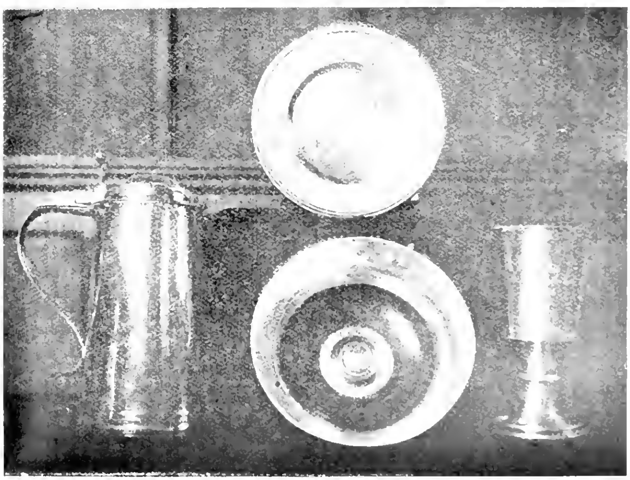


Photo. by [illegible] *Ep*[illegible]

Ancient Mazer in Epworth Church.

hard by, when he came to Epworth to bid farewell to his wife before his banishment by order of Richard II.

The vessel is now used as an alms dish; it is a curious bit of antiquity, and the most interesting object in the church. It is constructed of maple wood, mounted in

years in the possession of the Wesley family and as having been used in the Holy Service by John and Charles Wesley.

The chalice is dated 1706; it is very beautiful and of historic interest. The flagon is an ancient pewter.

The So-Called Copper Teeth of Cattle.

In the Deer Lodge Valley, Montana, adjacent to the great Butte copper district, the so-called copper teeth of cattle attract enough attention to make it worthy of record along with the "So-called Gold Coated Teeth of Sheep," as reported in "Knowledge and Scientific News," Vol. III., No. 15, page 359.

The lustrous copper or gold coloured coating (popularly called "copper teeth,") is general in this region in cattle, and occasionally seen in horses and sheep. The description of the "So-Called Gold Coated Teeth," referred to, accurately described the deposit found on the teeth in the cases here reported.

An analysis of this incrustation made by Mr. H. N. Thompson, Chief Chemist of the Anaconda Copper Mining Company, shows the deposit to be chiefly calcium phosphate, with some organic material, but no copper.

The report of the analysis shows:—

Insoluble residue,	CaO	35·5%
	P_2O_5	34·5%
Ignition loss	CO_2, H_2O, Organic Matter	25·0%

An interesting fact in this connection is that boiling seems to bring out the lustre, and many jaws which normally have a blackish or brownish colour, on boiling assume the copper or gold lustre.

It is worthy of note in this connection that these deposits occur in a region whose waters are strongly alkaline to cochineal solution, and further, because of the arid climate, there are large quantities of soluble soil constituents present, with a consequent high ash percentage in the plants grown upon it.

CORRESPONDENCE.

Electrical Nitrates and Fertilisers.

To the Editors of "Knowledge & Scientific News."

Sirs, While accepting "J. H. M. H.'s" correction as to the general destination of nitrate of soda as a manure, I should like to point out that the impression of its uses in promoting the growth of wheat is one which is widespread. For example, in the opening sentence of Mr. J. B. C. Kershaw's article, in the current number of *Science Progress*, on "The Artificial Production of Nitrate of Lime," he begins: "Since Sir William Crookes startled the scientific world, eight years ago at Bristol, by pointing out that the corn supply of the world was dependent upon the ample provision of nitrates to the soil, and that we were rapidly depleting our reserves of the only naturally occurring nitrate—namely, Chili saltpetre—scientists in all countries have been attempting to solve the problem of the extraction of nitrogen from the air in the form of nitrite or nitrate." I have referred to Sir William Crookes' own observations, and I find that he said: "It is now recognised that all crops require what is called a dominant manure. Some need nitrogen, some potash, others phosphates. Wheat pre-eminently demands nitrogen, fixed in the form of ammonia or nitric acid," and again, after a long passage referring to the cultivation of wheat alone, "The only available compound containing sufficient fixed nitrogen to be used on a world-wide scale as a nitrogenous manure is nitrate of soda, or Chili saltpetre. This substance occurs native over a narrow band of the plain of Tamarugal in the northern province of Chili. . . The nitrate fields of Chili have become of vast commercial importance, and promise to be of inestimably greater value in the future."

Sir William Crookes, who, of course, was unaware in 1898 of the experiments (quoted by "J. H. M. H.") taking place in 1905 at Rothamsted, went on to say: "The action of nitrate of soda in improving the yield of wheat has been studied practically by Sir John Lawes and Sir Henry Gilbert on their experimental field at Rothamsted. This field was sown with wheat for thirteen consecutive years without manure, and yielded an average of 11.9 bushels to the acre. For the next thirteen years it was sown with wheat, and dressed with 5 cwt. of nitrate of soda per acre, other mineral constituents being present. The average yield for these years was 36.4 bushels per acre, an increase of 24.5 bushels. In other words, 22.86 lbs. of nitrate of soda produce an increase of one bushel of wheat."

I trust that "J. H. M. H." will take steps to make Sir William Crookes aware of the extraordinary error into which he fell in believing that "wheat was in any sense dependent for its profitable cultivation upon nitrate of soda."

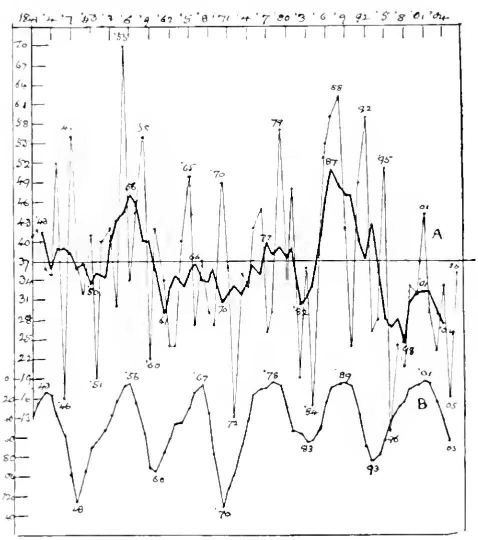
I am, sir,
Yours faithfully,
G.

Sunspots and Cold.

To the Editors of "Knowledge & Scientific News."

Sirs, In an article on "Coming Cold" in "Knowledge" for 1897, p. 241, is a diagram which seemed to me suggestive of a connection between sunspots and winter cold in the early part of the year (as measured by the number of frost days at Greenwich).

It might interest some of your readers to see how things have turned out in those nine years from 1897.



The thin curve A shows, then, the variations in number of frost days in the earlier half of each year, and in the thick curve each year point represents an average of five values. Below (B) is the inverted sunspot curve.

In that article I wrote: "It seems to the present writer that we are now about the beginning of another of those long waves of the smoothed curve of frost days, which may be expected to culminate near the next sunspot minimum.

At what date may we look for that minimum? Taking the eleven years' period as our guide, about 1900; but the interval, it must be remembered, varies. . . The new wave seems at least likely to be lower than the last, and more of the order of the two previous."

The new wave has turned out quite a small one, with crest in 1901, the year of sunspot minimum, the cold then showing (as in 1866) a relative maximum. Judging by the present position, we should at least expect no extreme cold (high number of frost days) in the earlier half of 1907. (I may remark that the total of frost days in September to May appears to present similar relations, though perhaps less definite.)

I am, yours, &c.,
ALEX. B. MacDOWALL.

To the Editors of "Knowledge & Scientific News."

Sirs,—I notice that you occasionally are good enough to answer queries from correspondents in your valuable monthly, which I have taken in for the last eighteen months, and I should be much obliged if you would explain the cause of the following phenomena.

Being very much interested in chemistry, and recently having had occasion to burn a small piece of phosphorus under a bell-jar for the purpose of seeing how much light was absorbed by the fumes, I held up the jar (with the plate at the bottom) to the light (incandescent gas). The mantle was visible through the fumes, and looked a milky blue colour, as one might expect. This was done when the fumes were densest.

When the fumes had subsided considerably I again held the jar to the light. I was surprised to see the fumes faintly (but distinctly) coloured in layers. The colour at the top was orange, then a thin layer of violet, then green, and lastly blue. Each layer blended imperceptibly with the next, like a spectrum, only apparently not quite in the same order. The best position for seeing the colours was when the jar was not quite between the eye and the light, but rather lower. When tipped to one side the colours kept the original horizontal level. When agitated the colours formed wavy lines, but soon regained the original level. As the fumes subsided more the orange colour gradually displaced the other colours until all the jar was diffused with an even orange colour. The jar used was 6½ ins. by 5½ ins., and the piece of phosphorus about the size of half a pea. The phosphorus was ignited by a hot wire, so that no other fumes were mixed with them. The colouring was not seen except between the eye and the light.

Apologising for troubling you,

I remain, Yours &c.,
P. H.

The Library, Buckhurst Hill.

[The colours are diffraction fringes formed in the same way as the colours often seen round the moon—the corona—when seen through a thin cloud. The blue fringe will be found to completely surround the flame, the tint gradually changing to orange outwards. The outer fringes are incomplete, due to the small size of vessel, and hence appear as bands. A.W.P.]

"Pendulums Used in Gravitation Research."

To the Editors of "Knowledge & Scientific News."

Sirs,—Kindly permit me to correct three errors which have occurred in reproduction of my diagrams on page 561 in your last issue, as they are liable to cause misapprehension.

1st. The dotted lines suggesting the changes of oscillation plane which distinguish the Foucault pendulum are omitted from Fig. 2.

2nd. The curious "smudge" upon the pendulum rod in Fig. 4 is not an intended portion of the diagram itself.

3rd. The ring in Fig. 7 to which the wire was hooked, and which was the distinctive feature of that pendulum, is omitted.

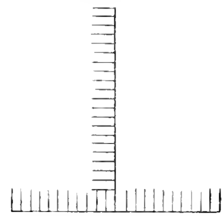
Yours truly,
W. H. SHARP.

Manor Park,
October, 1906.

A Peculiar Optical Effect.

To the Editors of "Knowledge & Scientific News."

Sirs,—I have frequently noticed a peculiar effect where a number of straight lines run in close proximity, which I am unable to account for. I refer to the fact that (to most eyes at all events) horizontal lines are more easily distinguishable than vertical lines. This is shown in the diagram I send herewith. One would be inclined, on first looking at it, to think that the horizontal lines were further apart than the vertical ones, yet on turning the whole paper round to a right angle, those lines which were vertical become horizontal, and are then much clearer than the others.



The effect may be even more noticeable if looked at from some distance. But now another curious result comes in. To my eyes, when the paper is held at a distance (say six feet), the horizontal lines are distinctly the clearer, but if I use strongish glasses, even though the lines be slightly out of focus, the vertical ones are undoubtedly the more distinguishable.

This effect has its practical value, for draughtsmen will find it better, when using a fine scale, to place it so that the lines run horizontally, turning the paper round if necessary.

Perhaps some of your readers can explain the cause of this.

Yours faithfully,
B.

Answers to Correspondents.

A. Handel Smith.—The most complete tables of physical and chemical data are to be found in Landolt-Bornstein, Physikalisch-Chemische Tabellen (Williams and Norgate, London). The Chemist's Pocket Book (E. and F. N. Spon) also contains numerous tables. It is impossible to advise further without knowing the particular tables required.

Halley's Comet.—Various dates have been put forward for the return of this interesting comet, but the data are not rigid, and consequently the predicted positions and times of perihelion are given with some variance by different authorities. The first predictions were for 1911, then 1912, but the most recent is that for 1910, May 24. May 16 of the same year has also been mentioned.

Artificial Respiration.

The newest method is that of Dr. Eisenmenger, of Hungary, who proposes to restore respiration by acting only on the abdomen, without causing any movement of the thorax. To this end he has devised an apparatus that enables him to increase or diminish at will the atmospheric pressure on the abdomen by a species of suction. A sort of cuirass, fitted with straps and a pad, is tightly fitted over the abdomen and lower thorax in such a way as to leave an empty space beneath the cuirass and the fleshy parts of the stomach and abdomen. The air in this hollow can be compressed or exhausted by means of a pneumatic tube and bellows, and thus the movable envelope of the abdomen can be alternately raised and depressed. Thus the rhythmic movement is transmitted across the soft internal organs to the diaphragm, which it moves in a corresponding way, thus causing inspiration and expiration. The heart is also affected, and thus gently massaged, and its movement stimulated.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Studies of the Sun's Heat Emission.

MM. CH. FÉRY and G. Millochau describe their preparations for making a new series of determinations of the sun's calorific emission, using for the purpose their pyrometric telescope. They consider the apparatus specially suitable for heat sources of definite area, as the recording part may be adjusted with great delicacy. For these experiments, a special form of the instrument has been constructed, consisting of a silvered-glass mirror, 103 mm. diameter, and 800 mm. focal length. At the focus of this mirror is placed a thermo-electric couple of similar construction to those employed in the Féry commercial pyrometric telescopes. Behind the thermopile is a total reflection prism serving to direct the rays coming from the mirror into an ocular, mounted on a movable dark hood. The observer looks into this in a similar manner to that followed when using a Newtonian reflector, and sees in the eyepiece the thermopile, forming a reticule superposed on the magnified image of the celestial object under examination. Delicate focussing mechanism is provided to adjust the reticule exactly at the focus of the mirror. The telescope tube proper is closed by a diaphragm composed of two metallic rings, one fixed, the other movable. Each ring has a sector opening of 60°, so that any required opening may be used, the actual amount being recorded on a divided circle.

The current generated in the pile is measured with a galvanometer having a movable coil.

By permission of M. Janssen, it has been arranged to make successive determinations at four stations of different altitudes, Meudon (150 m.); Chamounix (1030 m.); Grand Mulets (3,050 m.); Janssen Observatory, Mont Blanc (4810 m.).

The observations will be of two classes: (1) Measures taken at various hours of the day, by placing the centre of the sun on the centre of the thermo-electric reticule. (2) Observations of the various amounts of radiation of the several parts of the solar disc. This will be done by allowing the solar image to drift over the reticule, noting the galvanometer readings and the times; then by plotting the readings the values for any section can be deduced.

It is stated that the curves obtained thus far agree with those shown by Wilson's 1894 results. (*Comptes Rendus*, 143, p. 505, October, 1906.)

Recent Views on Terrestrial Magnetism.

M. Carl Stormer has for some time past been developing a mathematical theory of the aurora and magnetic perturbations in relation to Birkeland's hypothesis, supposing that these effects are due to electric corpuscles emanating from the sun, and moving under the influence of terrestrial magnetism. He gives certain of the formulæ derived by Poincaré's method, showing that it may be possible for a swarm of electric particles moving along certain trajectories to show evidence of perturbations more or less periodic. The velocities used in the discussion are those given by Rutherford for cathode rays, and the α and β rays of radium. The values determined are found to be of the same order as Eschenhagen's oscillations, and the dimensions of the trajectories vary greatly with the nature of the corpuscles. (*Comptes Rendus*, 143, p. 460, October 1, 1906.)

Colours and Spectra of Solar Prominences.

M. Ricco, observing at Alcala de Chisvert, in Spain, during the last total solar eclipse, on August 30, 1905, obtained direct photographic confirmation of the continuous spectrum of the solar prominences, which has been described by M. Deslandres. As seen visually, the prominences were of different colours in different parts; the bodies of the prominences were purplish red; the circumference of the chromosphere was purplish; and the summits of the jets were very clear purple, almost white, and very brilliant. Several chromospheric plumes were seen sufficiently colourless to correspond with the white prominences recorded by Lacchini.

Of especial interest are the results found on the photographs taken with a prismatic camera, showing monochromatic images of the uneclipsed parts of the solar surroundings. These show many important variations in the radiations of hydrogen, helium, and calcium. The photographic images of certain prominences in K light show a height of 79″-83″ while the same objects seen visually in the C line were only 64″ high. It is suggested that this greater height of violet radiation may be the cause of the phenomenon of white prominences. Several of the prominences show definite continuous spectrum from the red to ultra-violet (λ 3600). There appears to be a special class of prominence formed solely of calcium vapour.

Total Solar Eclipse of August 30, 1905.

Spectra of Chromosphere and Corona.—Professor F. W. Dyson has made a complete examination of the spectra photographed by him with the slit spectroscope, and included in the discussion the results obtained with the same instrument during the previous eclipses of 1900 and 1901. Observing in 1905, at Sfax, he was able to secure an excellent photograph of the corona spectrum, showing several new lines. The list of chromospheric lines given from the combined photographs is very complete, extending from λ 3347.98 to λ 5875.87, and shows the intensity, probable origin, laboratory intensity in spark or arc, and details by other workers for each line. Detailed discussion is given of the mode of occurrence of each element. It is noticeable that the helium lines and the element giving λ 4685.86, are stronger in the higher than in the lower chromosphere. The enhanced iron lines appear to be weakened in the higher chromosphere in comparison with the magnesium arc lines and the enhanced titanium lines. From the experience gained in these three eclipses, the author concludes that a slit spectroscope is most advantageously used when it is adjusted as nearly as possible tangential to the sun's limb at the point of second contact, this applying both to the chromospheric and the corona spectrum. The paper is illustrated by an excellent reproduction of the corona spectrum, showing the two new lines at 5117 and 5563.—(*Phil. Trans. Royal Society*, Vol. 206, Series A, pp. 403-452.)

Photographs of Corona. The Rev. A. L. Cortie took charge of the Stonyhurst College Expedition to Vinaroz, Spain. His chief instrument was the coelostat and long-focus lens belonging to the Royal Irish Academy, which had been used in 1900. Six photographs of the corona were obtained, the size of the moon's diameter being about 2¾ inches, the exposures varying from 4 to 50 seconds. After the very striking prominences in the north-east, the most conspicuous object is a group of plumes with a decided dark ray about position angle + 125°.2. The dark ray can be traced to about 12′ from the moon's limb, and both its darkness and its peculiar character differentiate it from the other rifts between streamers. As it rises it curves somewhat towards the north, and becomes broader. In negative 4, another dark ray seems to be superposed on the bright plume at position angle + 130°, but this cannot be traced on any other photograph. The paper is illustrated by four reproductions of the corona. (*Trans. Roy. Irish Academy*, xxxiii., Sect. A, Part I.)

Widened Lines in Sun-spot Spectra.

Professor C. Michie Smith has recently issued another circular, giving the lists of solar lines intensified or otherwise affected in sun-spot spectra. The observations extend from F to D, and cover the period 1905, July 5, to 1906, January 4. Thirty-three spots were examined, and an appendix shows the special points noted for several lines. (*Kodaikanal Observatory Bulletin*, No. 6.)

Oxford University Observatory.

In his report on the work of the University Observatory for 1905-6, Professor Turner states that the printing of the Oxford portion of the Astrographic Catalogue was commenced at Christmas, and the first of the eight volumes is nearly completed.

The expedition to Assouan, Egypt, to observe the total solar eclipse of August 30, 1905, was successfully carried out with the assistance of Captain Lyons. Several satisfactory photographs of the corona were taken with the astrographic object glass, one being through a green-colour screen. Pictures in polarised light were obtained with two small telescopes. It is hoped to measure these plates at the earliest opportunity.

The event of the year was the meeting of the International Union for Co-operation in Solar Research in Oxford, at the New College. Delegates from the various scientific institutions of the world attended and discussed the problems most in need of attention at the present time.

BOTANICAL.

By G. Massee.

Macroplancton of Paraguayan Ponds.

Dr. Chodat, in *Bull. Herb. Boissier*, distinguishes between Microplancton and Macroplancton, including in the former all microscopic organisms, and in the latter the larger free floating plants belonging to the Archegoniates and Spermatophytes, including species of *Salvinia*, *Utricularia*, *Lemna*, &c. Among remarkable species occurring in Paraguay are *Utricularia inflata*, common in swamps, having the inflorescence supported by verticillate leaves arranged in horizontal bands, cut into shreds at the extremities, and inflated at the centre. *Phyllanthus fluitans*, a curious plant belonging to the Euphorbiaceae, which simulates a *Salvinia*, occurs floating amongst species of *Salvinia*, *Azolla*, and *Lemna*. The leaves are almost orbicular, and float on the surface of the water. A broad, flat margin encircles two more or less dome-shaped elevations, one situated on each side of the mid-rib on the upper surface of the leaf. Two depressions on the under surface of the leaf, corresponding in position to the domes on its upper surface, are filled with imprisoned air, and serve as buoys to float the plant. The minute flowers are situated in the axils of the leaves. The stem produces numerous much-branched, positively geotropic root fibres devoid of root-hairs, and terminated by a short adherent cap. Another interesting swamp plant, *Alternanthera Hassleriana*, has a floating stem which attains a length of 20 cm., the internodes are cigar-shaped or spindle-shaped, hollow, and when young are covered with a dense coat of interwoven hairs. A quantity of air imprisoned in this felt assists in enabling the plant to float. Tufts of erect leaves, also the flowers, spring from the nodes. The roots spread outwards in two tufts from opposite sides of the nodes, thus preserving the equilibrium of the floating structure.

Anthoceros and its Nostoc Colonies.

The association of colonies of *Nostoc* and other allied forms of minute blue-green algae with certain of the more highly organised plants has long been known, and has led to much speculation as to the significance of such unions, but until quite recently no specific experiments have been instituted with the object of arriving at a more definite conclusion. Peirce has just described, in the *Botanical Gazette*, a series of experiments and cultures bearing on this subject, where *Anthoceros*, one of the liverworts, which has been supposed to habitually contain colonies of *Nostoc* in its thallus or vegetative portion. Minute filaments of the alga enter the substance of the liverwort through certain slits present in the surface of the thallus, and afterwards increase rapidly and form colonies in the substance of the thallus. Prantl has stated that *Anthoceros* derives benefit from the presence of *Nostoc*, assuming that the latter might fix the free nitrogen of the air, and contribute its products to the liverwort. He also points out that the liverwort forms free hairs, which penetrate into the *Nostoc* colonies present in its tissues, ostensibly for the purpose of absorbing the food-supply furnished by the *Nostoc*. Finally the thallus cavities containing the alga show a characteristic development. Peirce combats these statements as follows:—*Anthoceros* grown as pure cultures and quite devoid of *Nostoc* colonies proved to be more vigorous in every respect than others containing colonies of the alga, and, furthermore, many of the liverworts not grown as pure cultures, were also free from *Nostoc*. As to the statement that the blue-green algæ fix free nitrogen, it is pointed out that the weight of evidence is against this assumption. It is also shown that the structural peculiarities presented by *Anthoceros* when *Nostoc* is present are simply a matter of mechanics. The denser tissues surrounding a colony is due to pressure exercised by the constant increase in size of the colony on the surrounding tissues, and the ingrowth of hair-like structures into the *Nostoc* colony is due to the fact that the colony is not equally dense and resistent at all points of its surface, and hair-like outgrowths of the surrounding *Anthoceros* cells grow into the alien colony at the points of least resistance.

Zanczewske, on the other hand, considers the algal colonies as parasitic on the liverwort. This idea, however, is not supported by Peirce's experiments, although he is not prepared to state definitely that no parasitism exists, but concludes by stating that *Nostoc* certainly does not benefit *Anthoceros*, which, in fact, does better without it.

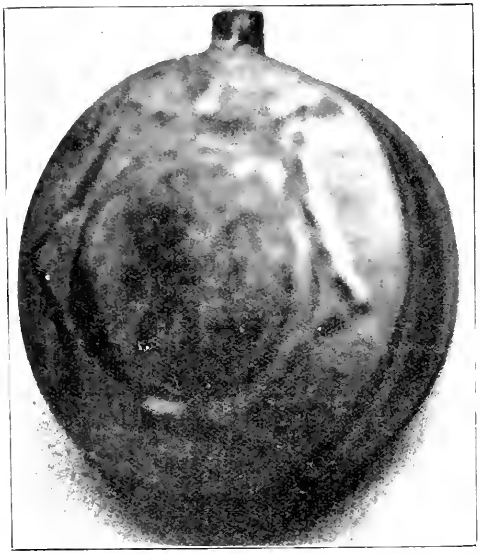
CHEMICAL.

By C. Ainsworth Mitchell, B.A. (Oxon.), F.I.C.

The Sacred Water of Mecca.

A recent issue of the *Lancet* gave the results of an analysis of water taken not long ago from the Zem-Zem well at Mecca, and it is interesting to compare the figures with those obtained by the present writer in the examination of the water brought back, in 1854, by Sir Richard Burton from his celebrated pilgrimage (see "Knowledge," 1894, vol. XVII., p. 50). The recent sample of the water was contained in a soldered tin bottle, in which was also a rusty-looking sediment, which proved to be iron hydroxide. The water, which Burton obtained at the risk of his life, was also sealed up in tin bottles of a peculiar shape, but in that case the only insoluble matter was in the form of beautiful silken crystals containing tin derived from the interior of the flask, and there was no iron present.

The *Lancet's* sample contained 200.2 grains of solid matter per gallon, 40.7 grains of chlorine, and 0.28 grain of nitrogen in the form of nitrates. The residue when heated gave off a sickening odour and turned black. The writer in the *Lancet* points out that the water contains about 90 times as much free ammonia as is present in ordinary water, and remarks that "to call it polluted would be mere euphemism." This fully bears out the present writer's conclusion, and is not surprising when it is remembered that for generations this water has been poured over myriads of pilgrims, who drank what they could as it ran down them and back through a grating into the well. Hence, the water has become little better than sewage effluent. That brought home by Burton contained 210 grains of solid matter, 69.3 grains of chlorine, 19.0 grains of nitrates, 5.3 grains of ammonia, and 0.22 grain of albuminoid ammonia. It was strongly saline, the chief salts present being ordinary salt and magnesium sulphate. Sir Richard Burton commented upon its extreme bitterness, and gave a humorous account of his attempts to make his fellow-pilgrims drink more of



Tin flask of Zem-Zem Water brought from Mecca in 1854 by Sir Richard Burton.—Four-fifths of actual size.

their dose of Epsom salts, while he "mocked at their scanty and irreverent potations." The water has evidently altered but little in its general characteristics of foulness during the last half century, and must still be regarded as permanently dangerous in itself, apart from the share it has been known to have from time to time in spreading diseases such as cholera.

Volcanic Ash from Vesuvius.

Specimens of the substances thrown up by Vesuvius during the last great eruption in April of this year have been examined by M. Cosyns, of Brussels. The ash was remarkable for the small amount of moisture it contained—only 0.28 per cent. On treatment with water it yielded 1.08 per cent. of soluble substances, consisting principally of calcium sulphate and sodium chloride. Roughly speaking, the ash was composed, in the main, of 50 per cent. of augite (a silicate in which iron and calcium predominate), 40 per cent. of biotite (a silicate containing aluminium and magnesium), and 10 per cent. of leucite (sodium potassium and aluminium silicate), magnetite, &c. There was a distinct difference in the characteristics of the ash which fell on April 4 and 5, and of that which fell on the 14th, the former containing much more moisture and a larger proportion of vitreous fragments. On extraction with ether the ash yielded a small amount of a combustible organic matter, which distilled at a high temperature, had a tarry odour, and became brown on exposure to the air. It was found to be a hydrocarbon, and was evidently identical with the substance which Silvestri discovered in the ash from a previous eruption, and termed "vaseline." Similar hydrocarbons have been found in the ash from other volcanoes, and M. Cosyns considers that volcanic activity is more or less closely connected with chemical reactions that lead to the formation of hydrogen and hydrocarbons, often in considerable quantity. Notable instances in support of this view occur in the volcanic regions of the Apennines, where the combustible gases carry bitumen and petroleum to the surface of the soil; in the petroleum wells in the volcanic districts of Baku; and in certain springs of petroleum in Canada, which issue from a volcanic rock containing nodules of extremely radio-active bituminous carbon.

A Chemical Test for Mould Fungi.

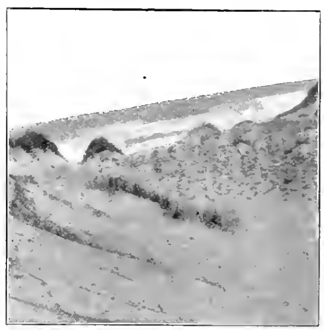
The action of certain mould-fungi upon cinnamic acid has been utilised by M. Oliviero as a means of detecting their presence. Cinnamic acid, which is closely related to benzoic acid, occurs naturally in balsam of Tolu and in storax, and can be prepared from these resinous compounds in the form of fine feathery crystals. It can also be prepared synthetically from oil of bitter almonds. When distilled with an excess of lime it yields cinnamene, C_8H_8, a liquid hydrocarbon with a very characteristic fragrant odour. The reduction of cinnamic acid to cinnamene is also effected by a ferment (enzyme) secreted by certain mould-fungi, notably *Aspergillus niger*, *Penicillium glaucum*, and probably others. Thus when a well-developed culture of *A. niger* is thoroughly shaken and filtered through porous porcelain, and the sterile filtrate brought into contact with a weak solution of the sodium salt of cinnamic acid, the unmistakable odour of cinnamene at once becomes apparent. So sensitive is the reaction that cinnamic acid may be used as a test for the moulds which sometimes form in medicinal preparations that have been stored for some time. It also throws light upon the occasional rapid deterioration of pharmaceutical products, such as balsam of Tolu, which contain cinnamic acid.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Sand-hills of the River Bush

THE illustration shows an excavation formed by marine action in the sand-hills, which are now found at the mouth of the river Bush, on the northern coast of Antrim, the town of Bushmills being about a mile up the river. Probably at one time the embouchure of the river extended the whole of the way as far as the town, with a width extending from near the Giant's Causeway across to the headland at Port Ballintrae. The present meanderings of



Sand-hills and Baylet at Mouth of River Bush.

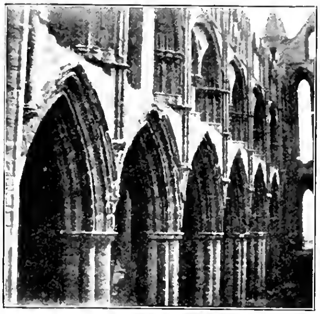
the river here are not, as is so often the case, the result of silting-up, but rather through the advance of sand-dunes blown inland from the ever-plentiful supply of sand forming along the coast. These low hills are devoid of consolidation, but are held together in some places by thick growths of grass. In the photograph a baylet has been formed, and this has been strewn with rounded blocks of basalt, from the disintegration of which the material of the hills has been derived.

Movements of Sand-hills.

Moving sand-hills have been the cause of much destruction. A well-known instance is that which occurred on the north coast of Germany, at the Kurische Nehrung. In 1809, the dunes stood between the sea and a church. By the movement of the sand the church was covered up in 1839. The moving dune passed on, and in 1869 the church was again completely visible, the dune then being on its landward side. Another similar instance is recorded, in which, between 1804 and 1827, a migrating dune in Prussia destroyed a tall pine forest, covering hundreds of acres.

Aeolian Denudation.

Nineveh was buried in aeolian sand two centuries after its destruction, and the fretting of the sand grains left the marks of its denuding action on the building stones. Our second illustration serves as a remarkable instance of the action of wind-denudation. The pillars and various portions of the stone-work of Whitby Abbey, besides exhibiting the ordinary effects of aerial denudation, are scored in a noticeable way, as though an endless rope had been continually drawn to and fro over them. The sandy waste seems to have been used over and over again as a kind of emery powder, and blown with terrific force against the sandstone pillars, and it has cut its way into the softer portions. This scoring can be seen in the illustration. The subject of aeolian denudation has received a good deal of attention in recent years, and is becoming a well-recognised factor in modern geology. It is not a little remarkable that the same principle is being utilised commercially, and the sand-blast is being used as a denuding agent in the cleaning of the faces of buildings in which sandstone has been used.



Aeolian Denudation at Whitby Abbey.

The Plateau Bridge into Europe.

In Dr. Felix Oswald's treatise on the "Geology of Armenia," we have a monument of original research and patient industry. Dr. Oswald has personally studied the whole of the formations here exhibited, and besides giving an account, running into 225 pages, of geological work already done in this part of Asia, he gives the record of his own original work to the extent of 257 pages, illustrated by sections and maps, fully elucidating the text. He gives us a striking picture of the Armenian plateau, forming a portion of that long plateaux-chain extending from the Aegean across to China, a portion of the colossal wrinkle which extends also westward through Europe, and speaks of the great mediterranean sea of Central Asia, now represented only by evaporating salt-lakes. Along this belt is the zone of thick sediments of Cretaceous and Eocene age, which were plastic enough to be thrown into mountain folds. A striking map of Asia shows this central uprisen series of plateaux, squeezed, as it were, between the great active mountain-making pressure from the north and the passive resistance of the ancient table-lands of Egypt, Arabia, Hindoostan, etc.

A Record in Geological Publication.

Dr. Oswald's book deserves special notice here. It is his thesis accepted by the University of London for the degree of Doctor of Science, but is remarkable from another point of view. It is printed from type set up by the author himself, and printed page by page from a hand-press. The labour involved must have been very great. The maps have also been reproduced by the author, and the whole goes to form a book printed so clearly and distinctly as to make it a pleasure to read it. I hope again to take an opportunity of referring to it. For the present, I should like to say that its contents fully justify its publication, that the edition is limited to a hundred copies, and that the author invites subscribers at a guinea each. Application should be made to him at "Iona," Beeston, Notts.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

The Bird Protection Society.

The Royal Society for the Protection of Birds, since its formation, has done more good and useful work than is generally realised. It is, therefore, with regret that we find ourselves compelled, for the moment, to enter a protest against some recent official utterances of the Society.

In a leaflet just issued (No. 58), we find the following stupid and ill-judged paragraph: "When it is regarded as a shameful and despicable thing to kill and possess the stuffed remains, or the egg, of a vanishing species, the private collector will probably cease to exist."

We are to suppose from this silly statement that the aim of the private collector is simply to complete the extermination of rare birds; and this, too, in spite of the fact that some of the most influential members of the Council of the Society are private collectors! The Society either knows too much, or too little, of the aims of the members who dictate its policy. Had the framers of this extraordinary paragraph levelled their guns at the collector of the eggs of British birds they would have hit many in this country very hard. The egg collector, is speaking generally, for there are many happy exceptions, a pest. And the man who gives long prices for rare birds British killed is only a little less mischievous. But between these "collectors," and the real student of birds, to whom a collection is an absolute necessity, there is a wide gulf, which the Society does not seem to recognise.

Glossy Ibis in Ireland.

It seems probable that a small flock of glossy ibises made their way to Ireland during September, since a young male is described in the *Zoologist* for October as having been shot on Twin Island, Belfast Lough, on September 6, while a second is reported in the *Field* (September 29) as having "recently" been shot on the Shannon, at Eyrecourt.

Hoopoe in Cheshire.

The *Zoologist* for October contains a record of the fact that a male hoopoe was "taken" near Chester, on August 29, this making the third record for the district.

Hobby in Cheshire.

We regret to note that a fine adult male hobby was also "taken" at Tarvin, near Chester, early in August, and has been presented to the Chester Museum. One of the most beautiful and most harmless of our falcons, it seems a pity that hooligans with guns cannot be induced to spare this bird.

Solitary Snipe in Norfolk.

Mr. Arthur W. Blythe writes to the *Field* (September 29) to say that a solitary snipe was shot by him at Melton Constable, on September 22, flushing the bird in a dry grass field.

Late Stay of Swifts in Somerset.

In the *Field* (October 6), Mr. F. A. Knight records the fact that he saw, on September 30, at 8 a.m., a large number of swallows and martins, and among them were two swifts. The birds were flying east, along the north side of the Mendip Hills, at Winscombe.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

The Efficiency of Brakes.

THE recent accidents in connection with the running away of an electric tram at Highgate and the train near Grantham have both called renewed attention to the non-effectiveness of brakes when applied so as to lock the wheels. The problems raised are very difficult, and it does not seem very clear as to what the correct solution is. At one time I thought that the explanation was easy, in terms of energy considerations. The argument ran somewhat as follows: If the wheels are locked there is dissipation of energy only at the rails; but if the wheels are only partially locked there is dissipation also at the brake blocks; therefore the energy of the train will be more quickly removed in the latter case. This argument is, however, wholly fallacious, and may serve as an illustration of the danger attending arguments based on the doctrine of energy. It is easy to see that it must be fallacious by applying the method of forces. The motion of the train as a whole can only be altered by means of *external* forces. Now, the forces between the brake blocks and the wheels are *internal* forces, and, therefore, cannot *directly* affect the motion of the train. The only external forces on the train are between the wheels and the rails, and the brakes act by changing the rolling motion of the wheels to sliding motion. Unless, therefore, it can be shown that the energy dissipated at blocks and rails is greater when the wheels are partially locked than when they are wholly so, the energy argument proves nothing.

The important question to be answered is as to whether sliding friction, even when the rails are slippery with rain (or otherwise) or a smooth flat is formed on the wheels, is likely to be less than the mixed rolling and sliding friction which comes into play when the locking is imperfect. If we take the supposed superiority of partial locking as being an experimental fact, the answer to this question must be that the sliding friction *is* less. It must be admitted that this answer is not in agreement with preconceived expectations. It is certain that pure rolling is much less than sliding friction; and it is not clear how a mixture of the two can give rise to a resistance which is greater than either of them. The greater smoothness brought about by the formation of a flat on the wheel commonly gets the credit for this unexpected result; and it is possible that this is a sufficient reason. Again, the grip-and-let-go action which accompanies the mixed friction may not be without some influence, since static friction is always somewhat greater than kinetic. This paragraph is written rather with the idea of getting clear notions on the subject than of dogmatising upon it.

The Rate of Decay of Phosphorescence.

This subject has been recently attacked by the Rev. B. J. Whiteside, S.J., who has experimented on Balmain's paint. The method of experimenting consisted in placing a surface coated with the paint alongside a piece of glass of such a tint that when illuminated from behind it appeared of the same tint as the paint when excited by light. The source of illumination of the glass was a small hole in front of a lamp, and its strength could be adjusted by moving the lamp and aperture from the glass. This movement was effected in such a way as to maintain the brightness of the glass always of the same strength as that of the surface of the paint, as the phosphorescence died away. By means of a chronographic apparatus, the mechanism by which the movement of the lamp was made (and which was controlled by hand), automatically recorded the times at which successive measured distances were reached. Hence, by applying the inverse-square law, the intensity at any instant could be calculated. As a result it was found that the intensity could be represented very well by the formula $I(a+bt) =$ const., where $I =$ intensity, a and b are constants. The great interest in this result is that a similar formula has been found by Professor Trouton to apply to the release of strain of solids when stressed beyond their elastic limits, and the plausible inference is that phosphorescence is intimately connected with the effects following an actual deformation produced by the action of light.

Models of Atoms.

Professor Mayer's experiment with floating magnets has been utilised considerably by Professor J. J. Thomson, in illustrating the possible stable positions of electrons in an atom. A simple modification of this experiment was described by me in *Nature*, Oct. 4. Small floating magnets (*i.e.*, bits of magnetised needle, ½-inch long, each pierced through a small piece of cork, so that it will float vertically on water) are placed on water with their north poles (say) all pointing upwards. These, of course, will repel one another and in the usual arrangement this repulsion is balanced by placing below the dish a bar magnet with its north pole upwards; the magnets then take up equilibrium positions, which are of a regular kind. But instead of using this additional magnet, a force tending towards the centre of the dish can be obtained by filling the vessel almost to overflowing with water. A single magnet placed on the water will then float to the centre; two such magnets will float into stable positions, depending upon their strength of magnetisation. Three come to rest at the corners of an equilateral triangle. The chief interest in this modification is that the grouping is sometimes very different from that obtained in the usual form of the experiment. For example, in the latter, when six magnets are used, they will form an equilibrium figure, with one acting as a central nucleus, and the rest distributed round it at the corners of a regular pentagon. In the modified arrangement, a large number may be arranged in a single ring without any central nucleus. The maximum number depends upon the size of the dish and the particular magnets employed. Thus in a particular dish, it is possible to arrange ten in a single ring. These also form a stable group as a ring of nine with one in the middle, or of eight with two in the middle. But a ring of seven with three inside is not possible; if temporarily so placed, one of the three moves out and joins the seven. Not until eighteen magnets are introduced is it possible to form a group with a nucleus and two rings. These are stable when placed twelve in an outermost ring, five in an intermediate ring and a single one in the centre. The moral to be drawn is that too much reliance must not be placed on applications to atomic structure of the behaviour in either of these forms of experiment, because the law of the forces between the constituents of an atom may be, and probably are, different from those existing in either of them.

ZOOLOGICAL.

By R. LYDEKKER.

The Fauna of Lake Tanganyika.

A CONSIDERABLE portion of the August issue of the Zoological Society's *Proceedings* is occupied by an account of the organisms obtained during a recent expedition to Lake Tanganyika. Several naturalists have taken a share in this work, and while some of them have not expressed a definite opinion on the subject, the general result of the investigations appears to show that the theory of the Tanganyika fauna being originally a marine one, which became cut off from the ocean and eventually adjusted itself to fresh-water conditions, will not hold good. Support to this view is afforded by a note in the same issue regarding a jelly-fish from the lake. Since the same species also occurs in the Victoria Nyanza and in the Niger, it is quite evident that this jelly-fish is a member of a fresh-water fauna common to a wide area in Central Africa, and in no wise distinctive of one particular lake. Of the naturalists who contribute to the "symposium," Mr. J. Calman writes emphatically against the marine theory, remarking that the Tanganyika shrimps, although peculiar, are essentially fresh-water types.

A Siamese Brown Bear.

My readers may, perhaps, think there is no more reason for referring to the occurrence of a brown bear in Siam than for mentioning that white elephants are a product of that country. As a matter of fact, the occurrence of such an animal in the area in question is very remarkable indeed, for brown bears and their immediate relatives (whether regarded as races or species) have hitherto been considered characteristic of more northern latitudes, such as are included by distributionists in the Holarctic region. The new brown bear, on the other hand, whose home is reported to be the Shan States, on the Burmese frontier of Siam, is (if its habitat be rightly located), an inhabitant of the Oriental, or Indian region. Hence my reason for referring to the description. According to Mr. O. Thomas, its describer, this bear, which has been named *Ursus arctus shanorum*, is nearly allied to the race inhabiting Hokkaido, the northern island of Japan, but differs by its inferior size and certain features in the form of some of the cheek-teeth. As the skin of the Japanese brown bear has not been described, no comparison in this respect is possible.

Two Noteworthy Fishes.

In the September number of the *Zoologist* Mr. A. H. Patterson, of Great Yarmouth, records the capture of a fish of the mackerel group, namely, *Scomber thunnina*, previously unknown to British waters. The specimen was taken in a drift-net off the Norfolk town, and measured about a couple of feet in length. It is a pelagic species of almost world-wide range, which has on several occasions been recorded from Scandinavian waters. The second fish to be noticed is a new shark from South African waters, near akin to the saw-beaked sharks of the genus *Pristiophorus*, but differing in having six (in place of five) pairs of gill-slits on the sides of the body, on which account it has been made the type of a new genus by its describer (Mr. C. T. Regan, of the British Museum), under the name of *Pliotrema warreni*.

Fish as Food.

The above is the title of an anonymous article in the September issue of the *Museum Gazette* (of which the Editor has been favoured with a copy). "Speaking in general terms," observes the writer, "there can be no hesitation in saying that most sea-fish afford nutritious, easily digestible, and thoroughly wholesome food. It matters little to assert that fish contains less nutriment than beef-steak. This only concerns the housewife in making her purchases. If the chemists have convinced her that it takes a pound and a half of cod to equal a pound of steak, and if the cost of the two is the same, let her choose the steak. At table all that is needful to remember is, that if you had intended to eat half a pound of steak, you must take rather more of cod to obtain its equivalent. The most concentrated foods are, however, by no means always the most suitable. Of all fish the herring is the one most to be commended. It is good in all forms fresh, lightly salted, or kippered and it disagrees with no one."

More Okapi News.

Although Major Powell Cotton has not succeeded in shooting an okapi (let alone procuring a live example), he has obtained the skeleton and skin of an adult, which will no doubt arrive in due course in this country. He also obtained some important information from the natives of the Ituri forest with regard to the habits of the creature. The okapi, it appears, is a shy, solitary creature, retiring to the impenetrable depths of the forest at the slightest indication of the presence of man. Four different kind of leaves form its food, and its drink is always drawn from a clear running stream.

REVIEWS OF BOOKS.

ARCHÆOLOGY.

The Egyptian Heaven and Hell. Vol. 1, The Book of Am-Tuat; Vol. 2, The Book of Gates; Vol. 3, The Egyptian Heaven and Hell. Crown 8vo, cloth, illustrated, 6s. net each. (London: Kegan Paul and Co., 1906.)—The three volumes in which Dr. E. Wallis Budge treats of the Egyptian Heaven and Hell are of surpassing interest to the general reader as well as to the student of Egyptian history and literature. They form volumes XX., XXI., and XXII. of the series on Egypt and Chaldæa, published by Messrs. Kegan Paul. The first of the three contains the complete hieroglyphic text of the book Am-Tuat, with translations and excellent and deeply interesting reproductions of all the illustrations. Volume II. contains the complete hieroglyphic text of the summarised form of the book Am-Tuat, and the text of the Book of Gates, with translations and reproductions as in Volume I. The third Volume, which the neophyte must attack first, contains explanatory chapters on the Books of the Dead generally. These books were designed to provide the souls of the dead with a guide to the journey that they must undertake in order to reach the Kingdom of Osiris, and furnished them with passwords to the "Islands of the Blessed." Among much that is superlatively interesting we can only note the curious and suggestive fact that in the later Dynastic Period the blessed were believed to live for ever in the Kingdom of Osiris, feeding upon the heavenly wheat of righteousness which sprang eternally from his body.

BOTANY.

Rambles on the Riviera, by Eduard Strasburger. Translated from the German by O. and B. Commerford Casey (T. Fisher Unwin; 21s. net). The fact that this book is by Dr. Strasburger, Professor of Botany at the University of Bonn, and universally acknowledged as one of the most brilliant of botanical investigators of his time, will naturally lead the reader to expect something exceptionally interesting, and his anticipation will be found fully realised. The author's many rambles have made him familiar with the beautiful scenery and natural productions of this favoured coast. In the introduction advice is given to intending visitors; to those in good health and only anxious to enjoy the charms of Nature; also to those whose state of health demands care as to choice of localities. Naturally the Flora receives the greatest share of attention, but the author's primary object was not to study botany or to write a history of the Flora of the district, but to enjoy the beautiful and interesting under whatever guise presented, hence we encounter sketches, told in charming language, concerning the peasants of the district, their traditions, folk-lore, &c., the ancient history of classic places destroyed by Saracens or attacked by Corsairs, the true account of the "Man in the Iron Mask," and many other equally fascinating incidents. In dealing with plants, not only those that are indigenous, but also introduced kinds receive attention, and the amount of information respecting their introduction, uses, ancient and modern, told in language free from the pedantry of attempting to pose as a man of science, as is too frequently the case, is quite a revelation. There is a very interesting chapter on plants furnishing perfumes, and the means of extracting the same as practised in ancient times and at the present day. Such headings as "Lemons in Symbolism," and the uses of palms in religious and other ceremonies also suggest interesting information. The beautiful garden situated at La Mortola, the property of Sir Thomas Hanbury, afforded the author many opportunities for conveying interesting information relating to plant life. In the translators' preface it is noted that it was at the suggestion of this generous patron of botany that the present work appears in an English garb. The book is beautifully printed, and the text is adorned by numerous well-executed coloured illustrations of flowering plants, seaweeds, butterflies, and vignettes of places of interest.

A Text-Book of Botany, by John M. Coulter, A.M., Ph.D. (Appleton; 5s. net). This book is intended for use in secondary schools, and represents the combined judgment of the author and many other experienced teachers, as to the nature of the material and the points of view. The result is a marked success, and places all concerned in the teaching of botany under an obligation to the author, not that books dealing with the subject are lacking, but in the majority of instances they are of such a nature that the author alone can possibly benefit by their production. A notable feature is the ring of life that pervades the book from beginning to end. We miss the usual chapters retailing in orthodox fashion certain structural features, definitions of leaves, flowers, &c. All these points are considered as a matter of course, but in conjunction with the reason for their presence. The living plant is the one object kept in view, and in this important essential the book differs from most others, which suggest an unwritten apology to plants for furnishing so many features of interest when viewed under a microscope. In addition to the parts dealing with structural and physiological matters and the larger groups constituting the vegetable kingdom, there are chapters on Plant Breeding, Plant Associations, and Forestry. The 320 illustrations are all good, some excellent.

The Study of Plant Life for Young People, by M. C. Stopes, D.Sc., Ph.D. (Alex. Moring; 3s. 6d. net).—An excellent book for young people desirous of learning the why and wherefore of plant life. The author commences by stating: "Many people do not realise that plants are alive." Quite true; in fact, there is no internal evidence in the majority of books on botany to prove that their respective authors realised this fact. The student is first led to realise that plants are living things by carefully indicating the signs of life presented by them, as breathing, eating, growing, moving, reproduction, &c. Simple and well chosen experiments that can easily be performed by the student are a noteworthy feature of the book. Although so essentially modern in tone, lapses to the old order of things are observable here and there, as, for example, when considerable stress is laid on the statement that some plants have not true flowers, &c. There are excellent chapters on "Plants in their Homes," and "Plant-Maps." Several whole-plate reproductions from photographs are excellent, but some of the figures in the text are scarcely up to the same standard.

CHEMISTRY.

Practical Methods of Inorganic Chemistry, by F. Mollwo Perkin, Ph.D., pp. viii. + 155 (London: A. Constable and Co.; 2s. 6d. net).—This little book is a model of what a practical text-book should be, and it supplies a distinct want. As the author points out, there are numerous handbooks devoted to the preparation of organic compounds, but none in which the same method of teaching has been applied to inorganic chemistry, and he has written this book to fill the gap. After an introduction and a chapter on general preparations and methods there come chapters dealing concisely with the preparation of salts, halogens, and halogen compounds, metallic oxides, acids, metals and metalloids, and the work concludes with a chapter on special preparations, followed by useful tables and an index. Theory accompanies the practical work step by step, and the student who has worked his way conscientiously through the different exercises will have gained a good grasp of the principles of chemistry. The book is well printed, and has good illustrations of apparatus where required.

Researches on Cellulose, II. (1900-1905). C. F. Cross and E. J. Bevan, pp. xi.+ 184. (Longmans, Green, and Co.; 7s. 6d. net).—Substances that would not yield crystallisable derivatives capable of being purified so as to be recognised as chemical individuals were for years shunned by chemists as unpromising subjects for research, and thus cellulose was long neglected, in spite of its importance as a structural compound in the vegetable world and its increasing use in manufacturing processes. It is largely owing to the systematic and untiring researches of Messrs. Cross and Bevan that we are at last beginning to know something of the probable constitution of the cellulose group of compounds, and the present work is another valuable contribution to a very difficult subject. The first section of the book gives a concise summary of the chemical reactions and structural form of cellulose. In the second section, which forms the bulk of the book, we find abstracts of various investigations made by the authors and others, with critical notes on the results, and a discussion of the possible bearing of these results on the chemical constitution of cellulose. Lastly comes a section giving a brief but most interesting account of the progress that has been made in the cellulose industries during the last five years. In the making of artificial silk, for instance, it is shown how what was little more than a curiosity in 1899, is now being manufactured at the rate of at least 7,000 kilos. per day, while the fibres of the best products are now so fine as to be only about twice the weight of the natural silk fibre. A short description of the different artificial silk processes is given, including the authors' own "viscose" process, and other uses of "viscose," such as in the sizing of paper and the manufacture of a plastic material, are also described, and the section concludes with suggested avenues of investigation in paper making, textile bleaching and finishing, and other industries. The book is excellently printed in clear type, and has a good subject index and an index of authors' names.

GEOGRAPHY.

Rhodesia: Geodetic Survey of South Africa. (Vol. III., Cape Town, 1905. London Agents: 36, Basinghall Street, E.C.; 146 pp., 10s.).—In spite of manifold discouragements this valuable work is making headway under the energetic direction of Sir David Gill, who is now, however, retiring from the post of H.M. Astronomer at the Cape, which he has so ably filled. This volume contains a convincing statement of the reasoning by which the Cape Government was brought to admit the importance and urgency of the Survey, and, better still, to sanction it. We read also of the special difficulties and dangers of the work, and of the troubles, some unavoidable, others due to regrettable misunderstandings, which hindered the progress of the Survey, and in particular one such misunderstanding, which cost two whole months at a critical time of year, and invalided one of the surveying staff, and thereby prevented the completion of the programme laid down, so that this volume does not quite cover the whole of Rhodesia south of the Zambesi. The Jäderin method, with Jäderin wire standards, was employed, and details are given of the elaborate precautions necessary to secure accuracy. The two base lines were at Inseza ($12\frac{1}{2}$ miles) and Gwibi ($13\frac{1}{2}$ miles), and astronomical determinations were made at Bulawayo, Thabas Inyorka, and two or three other stations. The chief of the expeditions was Mr. Alexander Simms, who had been employed at the Cape Observatory. This is a very important contribution to the projected survey from Natal to the Mediterranean along the 30° E. meridian.

The Dead Heart of Australia, by J. W. Gregory (London: Murray, 1906; pp. xvi. + 371; illustrated; price, 16s. net.) —Although, as indicated by its full title, which we have not space to quote, this work is primarily a record of an adventurous journey through the arid deserts of the Lake Eyre district in Central South Australia, it is really a very great deal more than this, and is, in fact, one of the most valuable contributions to the physiography and past history of Australia that has been made during recent years. To the naturalist the most interesting chapter is the one in which the author expresses his views as to the character and relationships of the Australian aborigines. That the "black fellows" are not the low and degraded creatures they have been commonly represented, Dr. Gregory is fully convinced; while he is further of opinion that, in place of being hybrids between Tasmanians and some other race (as supposed by Sir William Flower), they are pure-bred Caucasians, whose nearest relations are the Veddas of Ceylon; and, we presume, the primitive race recently discovered in Central Celebes. In this view the author is in accord with opinions expressed, independently of one another, by Dr. Alfred Wallace and Mr. Lydekker. Very interesting, too, are the fossil bird-remains discovered during the expedition, of which Mr. de Vis will doubtless give a full account in due course. Dr. Gregory has also something to say on cosmical and economical subjects. As regards the first, he bids us have no fear of the desiccation of our globe so long as the sun continues to give out its present amount of heat; while in respect to the proposal to flood the Lake Eyre district by a canal to the sea, the author points out that since the cost would run into tens of millions, the project is scarcely within the field of practical politics. A thoroughly entertaining book, containing a vast amount of scientific lore, is our verdict on Dr. Gregory's volume.

MATHEMATICS.

A System of Applied Optics. H. Dennis Taylor (Messrs. Macmillan and Co., 30s. net).—This is a notable book. Although many of the most important advances in optics have been made in England, there has been in recent years no text-book in England written from a practical standpoint similar to the important technical treatises of Czapski and Rohr published in Germany. Academical treatises there are in abundance and of high quality, but the standpoint from which these are written is such that in none of them is the subject treated in such a way as to enable a reader directly to calculate the form of lenses necessary for producing an efficient combination. This is the more astonishing inasmuch as Mr. Taylor, who now succeeds in supplying the deficiency, does so on the basis, not of any foreign text-book, but of an old English text-book, viz., Coddington's treatise on the reflection and refraction of light. The chief object in the present volume has been "to arrive at a complete system of algebraic formulæ of the second order which can be applied to any optical system likely to occur in practice with results which, in general, very closely approach to accuracy." This is done with the employment of quite simple algebra, so that no one need be deterred from reading the book on account of deficiencies in mathematical equipment. The reader is supposed to be already acquainted with the usual formulæ of the first approximation. He must master a new convention in regard to signs which at first sight looks somewhat elaborate, but which works out very well in the sequel. When so many conventions already exist no concern need be felt at the creation of a new one. We have nothing but admiration for the way in which the subject is developed, leading to formulæ which include and run parallel to Seidel's famous five conditions which require satisfaction in the production of a combination perfect to the second order. It is impossible to go into detail in regard to the general treatment. The characteristic note is the great freshness and originality everywhere displayed. There is no doubt at all that the treatise will rapidly take its proper place as one which will bring back to England its original prestige in optical matters. In regard to the style of publication there are two matters for regret. It is a pity that the numerous diagrams do not immediately accompany the text which they illustrate, but are collected together in the old-fashioned way in groups upon plate pages. It is also a pity that there is no index, although the orderly development of the subject makes this omission less important than it otherwise would be.

PHOTOGRAPHY.

The Year-Book of Photography. Edited by F. J. Mortimer, F.R.P.S. (London: "The Photographic News"; price 1s.). This annual has gone through many changes since it was established nearly fifty years ago. After a list of Societies, there follows a vast collection of formulæ that have reference to negative making, and then eight excellent articles on printing processes by as many different authors, with a large collection of formulæ appended to each, and then more formulæ and tables. Apparently all the instructions of the principal makers of photographic materials are included, and the source of these is obvious, but we should like to have seen the authorities given for a large number of formulæ, the sources of which are not acknowledged, and some of which are called "standard." We would suggest that this collection of formulæ might be suitably tabulated or brought into some system of expression, for then they would be much more useful to many who do not slavishly adhere to one maker's instructions, and those who do this can always get what they want from the maker whose goods they use. One example of the desirability for editing such a collection will suffice as an illustration. The two following are given on opposite pages; the source of the first is not stated, the second is headed "Rotary Stripping Films." They are sensitizing solutions for carbon tissue.

	1	2
Potassium bichromate	1 oz. - 35-50 grms.	1 oz. - 30 grms.
Water..	20-30 ozs. - 1000 c.c.s.	30 ozs. - 900 c.c.s.
Ammonia (·880) ..	60 mins. - 6 c.c.s	1 drm. - 3·5 c.c.s.

Obviously this is the same formula, and it need not have been set down twice, but the metric equivalents are peculiar. How one ounce can have the variable metric equivalent in one case and a quite different equivalent in the other, how 30 ozs. in the metric system can be less than 20 to 30 ozs., and as 60 minims are equal to one dram, how the metric equivalents can be so different as shown, would puzzle even an experienced worker.

Chemistry for Photographers. By Chas. F. Townsend. Fourth Edition (London: Dawbarn and Ward, Ltd.; price 1s. net.).—When a book has run to four substantial editions it may well claim to have established itself, and in a measure to be above criticism. However, the author can claim that he is only following in the footsteps of Hardwich and others in associating the word chemistry with photography more closely than seems to be justifiable. There is no chemistry involved in the publication of formulæ of solutions and the description of the operations of photography. It would have been better if the author had considerably restricted the scope of the book, for when "printing in salts of iron" occupies two pages, "printing in platinum" less than three, "orthochromatism" less than two, and so on, after practical instructions and formulæ have been given, there is little room for any chemistry.

ZOOLOGY.

A Text-Book in General Zoology. By H. R. Linville and H. A. Kelly (Boston, New York, Chicago, and London, Ginn and Co., 1906, pp. x. + 462, illustrated; price 7s. 6d.). —In this profusely illustrated little volume the authors—both well-known science teachers in New York—have initiated an entirely new mode of treating their subject. In place of starting with either the lowest or the highest group of animals (Protozoa or Vertebrata), they commence with the Arthropoda (insects and crustaceans), on the ground that, as the result of long practical experience, students can be more satisfactorily instructed on these lines than by any other method. Whether such a course will commend itself to English teachers, time and experience can alone demonstrate. So far as we can see, the treatment of the subject is remarkably even throughout, thus demonstrating the "all-round" training of its authors, and, when the number of illustrations is taken into account, the book is a marvel of cheapness. Whether it is not a little stretching terms to speak of the duck-billed platypus as "an ally of the squirrel," may, perhaps, be legitimate criticism.

MISCELLANEOUS.

George Bentham, by D. Daydon Jackson; pp. xii and 202. English Men of Science Series (Dent and Co.; 2s. 6d. net.). —As a botanist Bentham's reputation is secure, his achievements in this respect and the influence for good exercised by his sound knowledge of plants have been told elsewhere. The book under consideration will prove a revelation to many whose impressions respecting Bentham's character were formed from a casual interview in connection with scientific work, for although invariably courteous and sympathetic, his shy and reserved manner often suggested the idea that he was bored. Bentham commenced the study of botany as a boy, and thanks to his rank of birth and opportunity for rambling over Europe at an early age, he became acquainted with the leading European botanists, and familiarised himself with the floras of various countries contained in national herbaria. He studied for the Bar in a half-hearted manner, and finally decided to devote himself entirely to botany. Having determined on this course, he settled down to work in a methodical manner, and aided by good health, the possession of ample means, and a keen power of discrimination, he practically revised and placed on a truer scientific basis the flora of the world. Jackson reveals that, when off duty, Bentham in spite of his profound scientific knowledge was a society man, a lover of music, enjoyed whist, and was beloved by everyone whose good fortune it was to enjoy his friendship.

Brass and Iron Founding, by Joseph E. Dangerfield, is one of Messrs. Dawbarn and Ward's "Home-Workers' Series" (price 6d. net).—This is a thoroughly practical little book, which should prove of the greatest use to all those who have to undertake such work.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Use of the Microscope in Chemistry.

THE microscope is now the indispensable servant of so many branches of science that it is always a matter of wonder to me that it is so little used in chemistry. This is probably due to want of knowledge as to the capacities of the instrument, owing to the fact that the use of the microscope as such, and more especially as an instrument of precision, is practically untaught in our science and medical schools; though most workers with the microscope would listen incredulously were it hinted that they had anything to learn in such matters, their belief being that it is merely necessary to focus the objective and make a rough adjustment with the mirror, to get the best results of which the instrument is capable. However this may be, I believe that its aid would be of the utmost service to chemists in many ways, were it more generally used, but more especially, perhaps, in regard to qualitative analyses, where the amount of material available is minute. Dr. Wormley, in his "Micro-Chemistry of Poisons," states that by micro-chemical reactions, the one-hundred-thousandth of a grain of hydrocyanic acid, mercury, or arsenic, can be readily detected with only a few minutes' labour, and Behrens speaks of the detection of 0.006 μ gr. (0.000006 mgr.) of sulphur or bromine, 0.0014 μgr. of silicon, and 0.00126 μ gr. of magnesium. Minute as these quantities are, they are, of course, less delicate than some of the chemical reactions known to us, as in the ammonia process for the analysis of water, which can detect one part of albumen in ten million parts of water, or in spectroscopic analysis, which, according to Bunsen, is capable of detecting the three-thousand-millionth of a grain of sodium in the air. I believe, however, that further experience will show that micro-chemical reactions are themselves, sometimes, not only speedier, but more delicate than the older and better known methods, and there are many cases, where an exceedingly minute portion of substance is to be examined, in which this form of analysis is the only possible means of satisfactorily ascertaining its nature. For instance, I had myself, not long ago to investigate the contents of some sacs in a microscopic larva, upon which depended a rather important point of development. Such work would have been impossible by ordinary analytical methods, but though the whole process was carried on by polarized light and observed through a one-eighth-inch objective, the analysis itself was quite simple and straightforward, and resulted in unmistakably showing that the contents of the sacs were uric acid.

There is no doubt that methods of micro-chemical analysis need special initial training in the use of the microscope, and some preliminary patience until the slight difficulty of using an unfamiliar instrument in an unfamiliar way is mastered. They also need judgment as to when the microscope is likely to prove of service, and as to what may be fairly expected of it, and they need a natural neatness and orderliness in the worker, and some precautions with regard to the instrument and objectives. Prisms for polarized light are necessary, and the stage of the microscope should be of vulcanite or glass, whilst the objectives should be good, but inexpensive, and can be protected by attaching a small piece of broken cover-glass to the front lens of the objective by means of a little glycerine. Of course, the microscope may with advantage have many other refinements, such as those necessary for measuring crystallographic angles and axes, but these require special knowledge to utilise properly.

Preparing and Mounting Wood Sections.

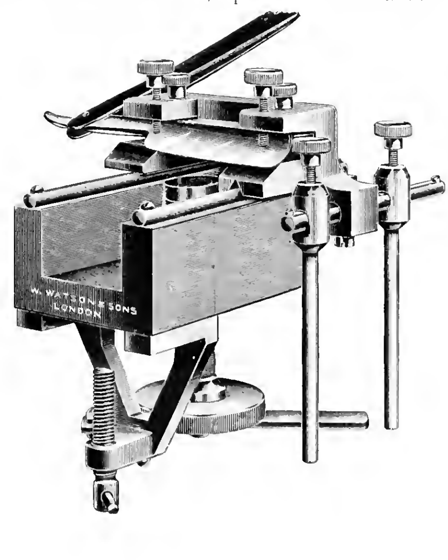
The mounting of wood sections is by no means a difficult matter, but attention must be paid to several more or less important details. For the cutting of the necessary sections, the knife must be of the finest steel and with the finest edge, and the microtome must be satisfactory also. I have found the ordinary English section-knife or razor insufficiently strong for this purpose, and a properly-sharpened plane iron, mounted between two pieces of wood to serve as a handle, is far better. The wood may need softening by boiling in water for some hours, or by soaking for some days. Hard paraffin must be used for embedding, as it holds the object more firmly and shrinks less, and though it will probably roll a little, a light pressure with the ball of the finger will rectify this. The thickness of the sections is a matter of some importance, and the general tendency is to cut them too thin. If transparency is required, the sections must be bleached, but this must be done with care, as over-bleaching destroys and disintegrates the fibres of the section, whilst insufficient bleaching gives a blotchy appearance. In most cases, it is sufficient to bleach until the colour is discharged from the wood, but no longer, and to follow with a very thorough washing in many changes of water. In this connection an "anti-chlor," such as hypo-sulphite of soda, might be used with advantage, but in any case the final washing must not be curtailed. A good bleaching solution, and one which is not too drastic, is chlorinated soda, made according to the instructions given by Mr. Cole, as follows: Dry chloride of lime, 2 ozs.; washing soda, 4 ozs.; and distilled water, 2 pints. Mix the lime in one pint of the water and dissolve the soda in the other. Mix the two solutions together, shake well, and let the mixture stand for twenty-four hours. Decant off the clear fluid, filter, and keep in a stoppered bottle in a dark place (to prevent dissociation), or cover the bottle with paper. If it is required to stain the sections, Delafield's hæmatoxylin, Bismarck brown, or, for double staining, Grenacher's borax carmine and methyl, or aniline green, are perhaps the most generally useful. The hæmatoxylin is frequently made in too strong a solution. It is best to stain slowly in a comparatively weak solution, and when using hæmatoxylin, it is a good plan to wash finally in hard water from a tap, as the lime salts have a tendency not only to deepen, but to fix the colour. The Bismarck brown is useful for very delicate structures, or for large spiral or scalariform vessels. The double staining is best carried out by immersing the section in borax carmine for twelve hours or more, washing quickly, but well, in fifty per cent. alcohol, placing for two or three seconds only in aniline or methyl green, washing as before, and then again staining in borax carmine until the red appears, changing the supply of stain after the superfluous green is driven out. It has been recommended to finally mordant the section in alum cochineal, but I have not myself tried this. The alcoholic solutions must not be mixed with the hæmatoxylin, which, in Delafield's solution, is a watery and not an alcoholic solution, and borax carmine is precipitated by strong alcohol. Almost any mounting medium may be used, but those which are used for sections in watery media are perhaps most suitable, such as glycerine jelly or Farrant's solution. Air bubbles will be found to be a nuisance, but these can be largely obviated by soaking in freshly-boiled water prior to mounting, and by carefully examining the sections under a microscope and working the bubbles out with a dissecting needle.

Staining Microscopic Animals and Plants on the Slide.

The ordinary method of fixing sections, and more especially serial sections, to the slide by means of egg-albumen can be readily adapted to the fixation of microscopic animals and plants. The albumen fixative is made as follows: White of egg, 50 cc.; glycerine, 50 cc.; salicylate of soda, 1 grm. Shake up well and filter, the last process being a slow one. Take a minute drop of the fixative and place it in the centre of the cover-glass and then smear it evenly so as to form the thinnest possible film. It is important that the slide should be absolutely clean and free from grease. Then place on the surface of the film a drop or two of water containing the organisms and allow the water to evaporate, protected from dust, until the film of fixative alone remains slightly moist. The slide can now be passed bodily through any fixing, dehydrating, staining, or clearing re-agents, and mounted in any desired way. The method is particularly useful with lowly forms of animal and plant life, especially the former.

The Cathcart-Darlaston Microtome.

Amongst inexpensive microtomes, the Cathcart microtome has long been a favourite. In its simplest form it is made with plain glass-bearing surfaces for use with an ordinary razor or planing iron, but a later pattern has brass slides, upon which runs a carrier



for the razor, and by this means more uniform and better graduated sections can be cut. Mr. Darlaston has just designed a simple, but effective, addition, which allows a definite thickness of section to be cut. The illustration shows the general principle. The forks A are attached to the knife carriage, and are provided with slots, so that their distance from one another can be increased or diminished as desired, and held clamped by means of thumb screws. The distance between these forks regulates the number of teeth by which the milled head raising the object to be cut is turned, thus regulating the thickness of the section. By this means any thickness from 1/250th to 1/500th part of an inch, or even less, can be cut, for the screw turned by the milled head has 40 threads per inch and the head itself has 200 teeth. Beyond the actual cutting of the section, the most important feature is the fact that it is automatic in action. The knife carriage is moved forward in the ordinary way, the section cut, and as the carriage is drawn backwards the milled head is turned and the object raised, so that with the next thrust forward of the knife in its carriage, the material has been raised the desired amount and is ready for a fresh section to be cut. When drawing the carriage backwards, however, it is advisable to slightly tilt it so that the back edge of the razor may clear the section. The automatic gear can be at once thrown out of gear when desired, and the milled head then rotated by hand. This microtome is supplied by W. Watson and Sons, with fittings for both imbedding and freezing, at the price of £2 5s.

Quekett Microscopical Club.

The Hon. Secretary informs me that the arrangements for the series of "Demonstrations in Practical Microscopy," mentioned in our October issue, page 573, are now complete, and will be given as follows:—

Friday, November 16, Mr. H. F. Angus, on "Axial Substage Illumination with Artificial Illuminant."

Friday, December 21, Mr. H. F. Angus, on "Darkground Illumination," including the means of obtaining a darkground with objectives of high aperture.

Friday, January 18, 1907, Mr. Chas. L. Curties, F.R.M.S., on "Polarised and Multi-colour Illumination," and "Various Methods of Recording Observations."

No demonstration in February on account of Annual General Meeting.

Friday, March 15, Mr. Conrad Beck, F.R.M.S., on "The Illumination of Opaque and Unmounted Objects."

Friday, April 19, Mr. Conrad Beck, F.R.M.S., on "The Comparison of Objectives," and "Mono-Chromatic Illumination."

Friday, May 17, Mr. F. W. Watson Baker, F.R.M.S., on "The Beginner in Difficulties," a supplementary demonstration which will also deal with any questions which may arise in the course of the preceding ones.

The demonstrations will be given at 7 p.m., at 20, Hanover Square, W. Cards of admission to the demonstrations and to the ordinary meetings may be obtained from the leading opticians, or the Hon. Secretary, Mr. A. Earland, 31, Denmark Street, Watford, Herts.

[Communications and enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for November.

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

The Sun.—On the 1st the Sun rises at 6.55 and sets at 4.33; on the 30th he rises at 7.44 and sets at 3.53. Sun-spots have lately been comparatively scarce.

The position of the Sun's axis and of the centre of the disc are given in the appended table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2 ..	24° 33′E	4° 8′	208° 38′
,, 7 ..	23° 35′E	3° 36′	142° 43′
,, 12 ..	22° 26′E	3° 2′	76° 47′
,, 17 ..	20° 2′E	2° 27′	10° 53′
,, 22 ..	19° 29′E	1° 50′	304° 57′
,, 27 ..	17° 48′E	1° 13′	239° 4′
Dec. 2 ..	15° 50′E	0° 35′	173° 10′

The Moon:—

Date.	Phases.	H. M.
Nov. 1 ..	○ Full Moon	4 46 a.m.
,, 9 ..	☾ Last Quarter	9 45 a.m.
,, 16 ..	● New Moon	8 37 a.m.
,, 23 ..	☽ First Quarter	12 39 a.m.
,, 30 ..	○ Full Moon	11 7 p.m.
Nov. 4 ..	Apogee	noon
,, 17 ..	Perigee	1 48 a.m.

Occultations.—The following table gives particulars of the principal occultations visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		a. m.	
Nov. 5	ν Geminorum ..	4·1	11 24	67°	12 34	276°
					p. m.	
,, 19	o Sagittarii	3·9	5 30	100°	6 34	247°
Dec. 2	χ^3 Orionis	5·1	5 33	111°	6 19	231°

The Planets.—Mercury (Nov. 1, R.A. $15^h 47^m$; Dec. S. 22° 28′; Nov. 30, R.A. $16^h 21^m$; Dec. S. 20° 18′) is an evening star, reaching its greatest easterly elongation of 23 on the 9th, and passing through inferior conjunction on the 30th. The elongation, however, is by no means favourable for observations of the planet after sunset, on account of the southerly declination.

Venus (Nov. 1, R.A. $16^h 45^m$; Dec. S. 27° 50′; Nov. 30, R.A. $16^h 19^m$; Dec. S. 22° 47′) remains an evening star until the 30th, when she reaches inferior conjunction with the Sun. On the 1st the planet sets at 5.26, or only 53 minutes after the Sun, and on the 30th, of course, the planet practically sets with the Sun. In the telescope the planet will present a thin crescent, 0·07 of the disc being illuminated on the 15th.

Mars (Nov. 1, R.A. $12^h 7^m$; Dec. N. 0° 32′; Nov. 30, R.A. $13^h 14^m$; Dec. S. 6° 33′) is a morning star, in Virgo, but is still too far from the earth for useful telescopic observation. The planet rises on the 1st at 3.21 a.m. and on the 30th at 3.10 a.m.

Jupiter (Nov. 1, R.A. $6^h 48^m$; Dec. N. 22° 47′; Nov. 30, R.A. $6^h 41^m$; Dec. N. 22° 57′) may now be well observed before midnight, rising on the 1st at 7.54 p.m., and on the 30th at 5.51 p.m. During the month the planet traverses a short retrograde path in Gemini, his apparent polar diameter increasing from 39″·6 to 42″·4.

The following table gives the satellite phenomena visible in this country before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Nov				Nov				Nov			
1	II.	Ec. D.	9 3	14	I.	Tr. E.	9 23	21	I.	Tr. E.	11 9
5	I.	Sh. I.	9 45	17	II.	Sh. I.	8 21	22	I.	Oc. R.	8 16
	I.	Tr. I.	10 51		II.	Tr. I.	10 13	24	II.	Sh. I.	10 57
6	I.	Oc. R.	10 15		II.	Sh. E.	11 10	25	III.	Sh. I.	11 5
8	II.	Ec. D.	11 39	18	III.	Sh. E.	10 1	26	II.	Oc. R.	10 25
10	II.	Sh. E.	8 35		III.	Tr. I.	10 45	28	I.	Sh. I.	9 55
	II.	Tr. E.	10 41	19	II.	Oc. R.	8 7		I.	Tr. I.	10 38
11	III.	Tr. E.	10 15	20	I.	Ec. D.	10 42	29	I.	Ec. D.	7 5
12	I.	Sh. I.	11 39	21	I.	Sh. I.	8 1		I.	Oc. R.	10 2
13	I.	Ec. D.	8 49		I.	Tr. I.	8 52	30	I.	Tr. E.	7 21
14	I.	Sh. E.	8 24		I.	Sh. E.	10 17				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Nov. 1, R.A. $22^h 43^m$; Dec. S. 10° 19′; Nov. 30, R.A. $22^h 44^m$; Dec. S. 10° 11′), in Aquarius, remains in a favourable position for observation, crossing the meridian at 8.3 p.m. on the 1st and at 6.9 p.m. on the 30th. The motion of the plant is retrograde until the stationary point is reached on the 13th, after which it is direct. At the middle of the month the outer major and minor axes of the ring are respectively 41″·3 and 4″·6, while the polar diameter of the globe is 16″·4. At 4 p.m. on the 23rd, the planet is in conjunction with the Moon.

Uranus (Nov. 15, R.A. $18^h 27^m$; Dec. S. 23° 37′), is unfavourably placed for observation, on account of its southerly declination and proximity to the Sun. The planet is in Sagittarius, setting at 7.35 p.m. on the 1st and at 5.47 p.m. on the 30th.

Neptune (Nov. 15, R.A. $6^h 54^m$; Dec. N. 21° 58′), rises shortly after 7 p.m. and crosses the meridian at 3.16 a.m. on the 15th. The planet is situated about 1½° N.W. of ζ Geminorum.

Meteors.—The principal meteor showers during the month are the Leonids and Andromedids; the Moon will be near *new*, and should therefore not interfere with observations this year.

Date.	Radiant.		Characteristics.
	R.A.	Dec.	
Nov. 14-16 ..	150°	+22°	Swift, streaks. (Great Leonid shower)
Nov. 17-23 ..	25°	+43°	Very slow; trains. (Great Andromedid shower)

Algol will be at minimum at 9.34 p.m. on the 15th, and at 6.23 p.m. on the 18th.

Telescopic Objects:—

Double stars: η Cassiopeiæ $0^h 43^m$, N. 57° 17′, mags. 3½, 7½; separation 5″·7. Binary star.

λ Arietis $1^h 52^m$, N. 23° 6′, mag. 4, 8; separation, 37″. Components white and blue; easy with power 20.

η Persei $2^h 44^m$, N. 55° 28′, mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

Knowledge & Scientific News

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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

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Lightning Flashes from Earth to Cloud.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

"Ah, Thomas,
"That lightnings that we think are only Heaven's,
"Flash sometimes out of Earth against the sky."
Tennyson, *Becket*.

As long ago as the year 1856 James Nasmyth remarked (British Association Report, 1856, p. 14) that in many cases of lightning flashes which he minutely observed the course of the flash was from the earth *upwards* towards the heavens.

Again Dr. T. L. Phipson (Familiar Letters, &c., 1876, p. 195) mentions that Admiral FitzRoy describes a thunderstorm off the coast of La Plata when the whole heavens appeared like a metal foundry so numerous were the flashes. Neither his own ship nor another about a mile distant were struck, but the sea between them was several times, and in one instance the lightning appeared to rise from the surface of the water. Dr. Phipson, in another place, also wrote that "a few cases are on record of these upward strokes of lightning in various authors."

Another case of the observation of an earth-to-cloud flash is that which was communicated to me by my friend, Mr. Seymour H. Beale, of Banbury, in relation to a thunderstorm which occurred in that town on July 9, 1905.

"At 11.30 a.m. it was very hot and close with no breath of wind stirring. About noon distant thunder was heard, which continued until 12.20 p.m., when the clouds took a fearful shape, but were not very dense. Then came an enormous *upward* flash from the ground to the cloud (I have several times seen these upward flashes in this neighbourhood, but nowhere else), accompanied directly after by a minute downward flash quite 10 degrees to the east of it. The flash was about three miles off. . . . Then downward flashes came rapidly and vividly. . . ."

From the above it will be seen that Mr. Beale, who is a very careful observer, was distinctly able in his own mind to differentiate between upward and downward flashes, and it is interesting further to note his remark that upward flashes seemed to be special to the neighbourhood of Banbury.

The above observations, and others might be cited,

Photo by J. W. Bridges.

Fig 1.—Cloud-to-earth discharge showing the ramifications directed earthwards. August, 1906. Chadwell Heath.

indicate that flashes from earth to cloud have been definitely recorded.

Turning now to a lecture on "Thunderstorms" delivered by Prof. Tait in the Glasgow City Hall on January 29, 1880, we find that he regarded the origin of such an observation as subjective, as can be gathered from the following extract :—

"A remark is made very commonly in thunderstorms, which, if correct, is obviously inconsistent with what I have said as to the extremely short duration of a flash. Even if we supposed the flash to be caused by a luminous body moving along, like the end of a burning stick whirled around in a dark room, it would pass with such extraordinary rapidity that the eye could not possibly follow its movements. Hence it is clear that when

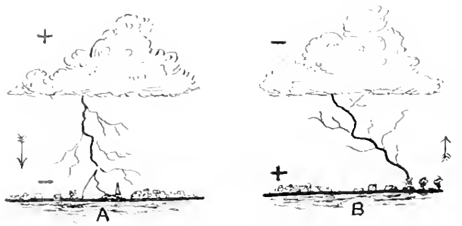


Fig. 2.—Diagram to illustrate the direction of the ramifications from the main flash when the discharge is from (A) cloud to earth and (B) earth to cloud. The main discharge is in both cases from + to −.

people say they *saw* a flash go upwards to the clouds from the ground, or downwards from the clouds to the ground, they must be mistaken. The origin of the mistake seems to be a *subjective* one, viz., that the central parts of the retina are more sensitive, by practice, than the rest, and, therefore, that the portion of the flash which is seen directly affects the brain sooner than the rest. Hence a spectator looking towards either end of a flash very naturally fancies that end to be its starting point." (Thunderstorms, p. 9.)

It will be gathered from the above extract that Prof. Tait only regards the observation of the direction of the flash as impossible, but in no way suggests that flashes from earth to cloud do not occur.

In my own case I have never been fortunate enough to observe an earth-to-cloud lightning flash, but I have very carefully observed a great number of flashes which I regarded as travelling from cloud to earth, in spite of the fact that in many instances my eye was directed towards the horizon; these flashes, according to Prof. Tait, should have been noticed by me as *upward* discharges.

Further, I have watched numerous *ramified* flashes, that is, discharges which have branches or tributaries like a river, and a strong impression has been formed in my mind that these ramifications were not quite simultaneous with the main stream. This observation can, however, be easily explained, as most probably the brightest part of the flash, the main stream, would effect the retina before the fainter portions, namely, the ramifications.

The examination of a large number of photographs of ramified flashes taken with *moving* cameras has convinced me that my impression of the apparent lateness in the appearance of the ramifications was incorrect. The photographs indicate that they occur simultaneous with the main stream, since they are joined to, and not separated from, the chief channel of discharge. An example of such a photograph will be seen in the left-hand flash shown in Fig. 7 (this figure will appear in the second part of this article), which was taken by a camera rapidly moving from left to right horizontally.

One cannot, however, be too careful in checking eye observations and impressions by photographic methods whenever possible, and it is in this respect that the camera is such a valuable aid to science. The eye gives us only a temporary view, which is gone for ever, but the photographic plate provides us with a lasting record, which can be studied at leisure.

Assuming, therefore, that the eye is not able to detect the direction in which a single flash is proceeding, owing to the extreme rapidity of travel of the electric current, a way is open to us, I think, of determining by photography whether a flash is going from earth to cloud or from cloud to earth, with the proviso that the discharge has ramifications.

If we turn our attention for a moment to the action of an electrical machine, we find that when a spark is made to pass from one pole to another, the ramifications from the main spark are always in a certain direction, namely, from the positive to the negative pole, *i.e.*, in the general direction of the main discharge. In fact, as Prof. Silvanus Thompson states in his excellent "Elementary Lessons in Electricity and Magnetism" (Edition 1895, p. 303), "the branches always point towards the negative electrode."

If anyone makes a study of the direction of ramifications in photographs of lightning, he will find that the ramifications are directed earthwards in about ninety-nine cases out of every hundred. The accompanying illustration (Fig. 1) gives an example of such a discharge, and is a reproduction from a photograph taken by Mr. J. W. Bridges in August, 1906. The deduction to be made from this fact is that in most cases the

Photo by Mr. James Crosbie.

Fig. 3. A discharge which has the appearance of a flash from earth to cloud. This is, however, very probably only an effect of perspective. Erith, 1894.

discharge is a cloud-to-earth one, and, therefore, the cloud is the positive and the earth the negative pole.

It can, and does, happen, however, that clouds may be negatively charged, and this has often been made apparent to us by flashes of lightning passing between cloud and cloud.

The question now arises, Can the earth become positive, or, in other words, can a lightning flash be an earth-to-cloud discharge? This question, I think, is answered by the few photographs which accompany this article, for the ramifications in each case are all directed cloudwards and not earthwards.

It may be useful to show diagrammatically (Fig. 2) the two main conditions mentioned above, namely, (*a*) when the cloud is positive and the earth negative (the common case); and (*b*) when the signs are reversed (the exceptional case); the arrows indicate the direction of travel of the current in each case.

It will then be seen that the general trend of the branches indicates the direction of the discharge, and this can be determined as easily by the eye as it can be recorded by the photographic plate. The reader's attention will, however, here be restricted to photographs alone, for they can be examined at leisure. Although I have examined some two hundred photographs of lightning flashes, I have only come across two which, in my opinion, are, without doubt, earth-to-cloud discharges, one of them, which shows two such flashes, being a nearly perfect example. The third photograph represents also, I believe, an upward discharge, but it *may* be an exceptional effect of perspective upon a cloud-to-earth flash. One has to be exceedingly careful in differentiating between photographs of true earth-to-cloud discharges, and those which appear like them, but are really due to an effect of perspective. Several photographs which I have examined appeared to indicate an upward trend of the ramifications, but in nearly every case the directions of the branches could be explained without difficulty in the above manner.

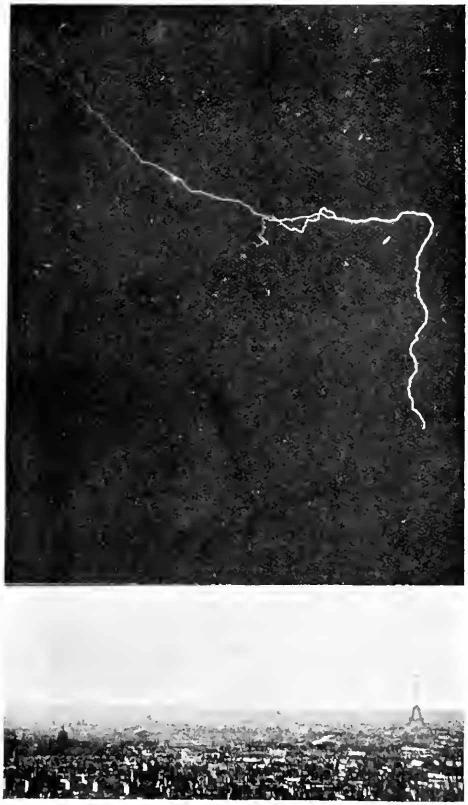


Photo by Monsieur G. Mesmer.

Fig. 4.—A lighting flash from the Eiffel Tower to a cloud. Paris, July 31, 1904.

It is, therefore, important to treat as typical cases of earth-to-cloud flashes only those photographs which show the earth and cloud ends of the flashes in the field of view of the camera. This means, therefore, that such photographs can only be secured when the flashes are some distance away from the photographer.

A case of a very probable perspective effect of a cloud-to-earth flash is that shown in Fig. 3. This excellent photograph was taken by Mr. James Crosbie, of Erith, in 1894. The flash commences in a cloud some distance away behind the trees, and comes towards the observer. The single stream, which, in the first instance, is thin, because the flash is so far distant, splits up into two branches, as the observer is approached; each of these becomes more intense, and, therefore, broader, because they are getting nearer the observer. The flash probably reached earth somewhere behind the photographer. The ramification towards the right of the photograph has also a direction inclined rather towards the camera, but it was apparently dissipated before it reached earth.

Coming now to the first of the earth-to-cloud photographs, we have an excellent example in the interesting flash shown in Fig. 4. This was taken by Monsieur G. Mesmer at Paris on July 31, 1904, at 11h. 45m. p.m. The upper portion of the picture was the actual photograph secured, but owing to the faintness of the landscape in the original negative, a similar view was taken by him the next day from the same position with the same camera. This view has been placed exactly below in the illustration, so that the top of the tower should be imagined to be at the lower extremity of the flash.

The flash itself emanated from the top of the Eiffel Tower. It made a sinuous path upwards, and then evidently met a stratum of air through which it could not easily pass; this caused it to alter its direction (towards the left in the photograph). The flash then split itself into two, each of the branches becoming fainter and eventually discharging themselves in the clouds in the upper air.

It seems to me more easy to explain the peculiarity of this flash as an earth-to-cloud discharge than to imagine the probability of two flashes meeting together in the air and pursuing the same track to the earth.

It may be of interest to the reader to know that when I suggested to Monsieur Mesmer that this flash was of a peculiar nature and I felt bound to consider it as an earth-to-cloud discharge, he wrote :—

"Your remark on the subject of the flash with an upper bifurcation appears to me quite correct. It is manifest that this discharge ought to be directed from the Eiffel Tower towards the clouds. I had not remarked this peculiar character of this flash, and Monsieur Emile Touchet, to whom I have sent a print of this photograph at the same time as the others which have been published, has also doubtless not perceived it, as he did not mention it to me. What did appear remarkable to me about this flash was that it was visible in the whole of its development (from beginning to end), and struck, or rather flowed, from a well-known terrestrial object. . . ."

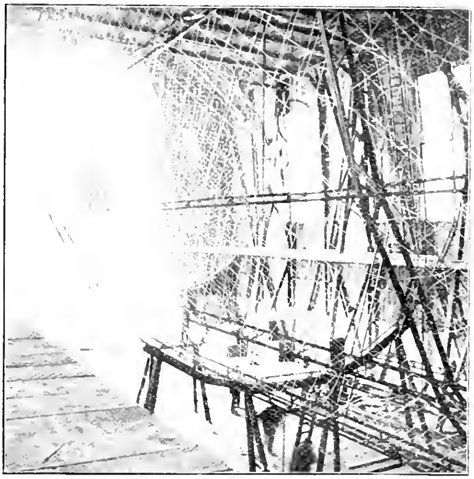
(To be continued.)

The Latest Developments in Aerial Navigation.

By MAJOR BADEN-POWELL.

DURING the last month or so several important advances have been made towards the conquest of the air, and the subject has been much "boomed" in the daily Press. An important lecture dealing with the matter was given on November 15, by Colonel Fullerton, R.E., before the Royal United Service Institution.

Santos Dumont has, as usual, been well to the fore, and has attracted the attention of the multitude. But it may be said at once that, as on previous occasions,



Zeppelin Airship—The Bows.

his exploits have been glorified quite beyond their real significance. Many of the papers have hailed this inventor as the first man to fly, ignoring the many attempts that have hitherto been made with almost as much success, and quite forgetting the very brilliant achievements of the Brothers Wright, who have far surpassed anything that Santos Dumont, up to the time of writing, has accomplished. It may, perhaps, be of interest to briefly recapitulate the known occasions on which men have been raised off the ground by machines of the "heavier-than-air" type. Apart from gliding machines, which are not intended to rise by any inherent power, there are three machines that we know of, besides those mentioned, that are supposed to have risen off the ground, lifting their entire weight. The first is that of Sir Hiram Maxim. In 1894, this huge machine was travelling along its railway track at a rate of some 40 miles an hour, when it broke loose, and made something of a jump through the air before falling to the ground. We need not now re-open the discussion as to whether or not this can be considered as a true flight. For the moment all we need be concerned with is as to whether a machine carrying a man or men has risen off the ground. Later on we will draw the distinction between this and true flight. The next event worth chronicling was the trial of M. Ader's apparatus, in 1897, which is said to have risen with its inventor aboard, and travelled for some yards through the air. The third ascent of a man-carrying machine was in 1901, when Herr Kress rose, with a system of aeroplanes, from the surface of a lake, but fell back into it.

These efforts can, however, hardly be considered as really successful flights, but they clearly prove that a machine on the aeroplane principle, if propelled by sufficiently powerful propellers, can rise off the ground and lift human beings with it. This is an important point, since many writers have cast doubt on the possibility of being able to accomplish even this much.

Stability while progressing through the air is another matter altogether. Experiments with models prove it to be a problem involving many complications and difficulties. It is, at present, very doubtful if M. Santos Dumont has solved to any great extent this problem.

His machine has on each occasion fallen heavily to

The Main Framework.

the ground, after but a short flight. We are not now considering the future, but only what has actually been done, for in all probability this energetic inventor will bit by bit improve his apparatus so as to overcome any tendency it may have to upset. Still, so far, he has not done more than to improve slightly on the experiments referred to. This machine, it may be as well to mention, consists of two superposed aeroplanes, slightly concave on the under side, 39 feet across, and 11 feet wide, being 7 feet apart, and divided into compartments by six vertical divisions. These planes are placed at a slight diedral angle, and the area is reckoned as 861 square feet. From the front of the lower plane extends a long, box-like tube, supporting a box to act as rudder. A 50-horse power Antoinette motor is now used, replacing an older one of 24-horse power. This rotates a single two-bladed screw propeller, six feet in diameter, in rear of the centre. The propeller is connected direct to the motor shaft, which turns it at a rate of 1,500 revolutions per minute, and is said to give a thrust of 330 lbs. The total weight lifted is put at 650 lbs.

While public interest is, for the moment, absorbed in the thought of the attainment of flight on the heavier-than-air principle, two very marked advances have been made with propelled balloons, and if such machines are not to be considered as the ultimate ideal of aerial navigation, yet improvements have now been accomplished in their construction, such as to render them practical engines of war. Count von Zeppelin, the veteran German general, who has for so many years been pluckily striving against difficulties and misfortune, has at last acheived unqualified success with his immense airship. This apparatus, as re-constructed, consists of a huge frame-work of aluminium, 430 feet long, over which a smooth outer covering is arranged, and within which, 15 balloons are placed. The two separate engines are each of 85-horse power, working four small screws, placed on each side of the vessel.

The photographs which we reproduce, are of special interest, as having been taken during the process of building the machine, and never before published. They clearly show many of the details of construction. Immense hoops, about 36 feet in diameter, are constructed of lattice girder-work of aluminium, rivetted together. These are all connected together with a series of longitudinal girders of similar construction. Over this framework is tightly stretched a netting of hemp cord, both inside and outside, so as to make two layers of netting to allow a space between the inner and outer skins. The vessel is further stiffened by transverse nettings, forming partitions to keep the internal balloons apart. Over the whole, an outer varnished silk covering is tightly stretched, so as to form a smooth surface to drive through the air. The general shape, as is well-known, is a long cylinder with ogival ends. The extreme point of the bow is formed of a hemispherical aluminium cap, and may be noticed in one of the photographs, where it appears against the light of the sky, almost as if unsupported.

This vast airship underwent many vicissitudes, and was several times reconstructed, but on the 9th of October last, it rose from its platform on Lake Constance, remained for about two hours in the air, manœuvring over the lake, and finally, returned safely to its shed. The maximum speed (taken accurately by theodolites) was 12 metres per second, or just on 30 miles an hour. It has often been remarked that the real test of the practicability of an airship is its ability to attain a sufficient speed to stem any ordinary wind. A speed of 30 miles an hour should certainly be sufficient for this, and even if the machine is not capable of progressing against a strong wind, still it should be able to manœuvre on any average day.

The third machine to successfully take the air is the new Lebaudy, "La Patrie," which has been built to the order of the French Government. This is, in general arrangement, very similar to the last Lebaudy, but incorporates many minor improvements. The volume is 3,200 cubic metres, and the engines, of Panhard make, develop 75-horse power.

On November 16, she made her first trial trip, remaining two hours and 20 minutes in the air, and attaining a speed said to be 20 miles an hour. Six passengers were on board. Since then further trials have been made with complete satisfaction, the greatest speed attained being given as 28 miles an hour. Considering the remarkable performances of the first Lebaudy, it is to be hoped that this vessel will prove thoroughly serviceable.

Thus both the French and the German armed forces may now be considered to include aerial machines. It is already rumoured that the French are building more, and, without doubt, the Germans and other nations will quickly follow suit.

The Flight of Flying Fishes.

Lt.-Col. Durnford's Arguments.

FROM Lieut.-Col. C. D. Durnford we have received a copy of the second paper which he has contributed to the *Annals and Magazine of Natural History* on "The Flying Fish Problem." Lieut.-Col. Durnford, as readers of the Natural History Notes will be aware, is the opponent of the aëroplane theory of the flying fish's flight, and believes that the flight is accomplished by a very rapid movement of its fin-wings. In a paper published last January he endeavoured to show that the wing surface of a flying fish was not great enough to support the weight of a flying fish considered as an aëroplane. "The argument was based," to quote the paper before us, "upon the fact that as a flying animal the flying fish is equipped with wings of a fractional sailing value compared with those of a sailing bird. Also that if the wings were many times larger, so as to bring the fish on an equality with the bird in this respect, it could only sail with the bird's limitations as regards direction of the wind, and with the bird's frequent assistance from rowing flight."

The difficulty of deciding the vexed question appears to have arisen from the fact that many people, perhaps most people, are unable to perceive the motion of the wings. By Lieut.-Col. Durnford this is attributed to defects of vision, and he remarks that he himself and other witnesses are able to see the movement. One of his latest witnesses has had abundant opportunities of observation during the last year. In a paper dated October, 28, 1905, Brig *Galilee*, North Pacific Ocean, Dr. J. H. Egbert, Carnegie Expedition, writes: "Though still denied by some observers, the power of propulsion through the air by means of its fin-wings is generally accorded the flying fish. During months at sea in the tropics the writer has almost daily watched the flying fishes and studied their flight through the air. . . . The difficulties of assuring oneself that the flying fish moves its wings during its flight through the air are well understood, and also the fact that these difficulties are generally removed when opportunity is afforded of observing the flight of certain of the larger species under favourable conditions. That flying fishes use their wings after the manner of birds, at least upon emerging from the water, can hardly be denied, since from the forecastle head of a ship plying the waters of the lower latitudes this wide birdlike motion of the fin-wings may be easily observed as the large flying fishes break water almost under the vessel's bow. This flapping motion of the fin-wings is not, however, long maintained, but as soon as the fish is well started in the air apparently passes into a vibratory motion of the appendages so rapid as to be almost beyond human visual perception."

Mr. Lionel E. Adams (*Zoologist*, April 4, 1906) is another witness in favour of Lieut.-Col. Durnford's beliefs; and, to a slighter extent, Mr. F. G. Aflalo. But the circumstance in which Lieut.-Col. Durnford relies is less that of the perception of the wing movement by observers, than on the impossibility that an aeroplane, whether it were in the form of a bird, a bat, or a flying fish, could glide with and against the wind and at an angle with the wind, and describing curves which would bring it round in a semi-circle—unless it were propelled by some wing flapping motion. The following is, he thinks, probably a fair description of the flying fish's methods in an ordinary flight :—

1. The tail impelled and visibly wing assisted jump from the water to a height where the wings can work freely.

2. The flight continued by an intensely rapid and laboured wing-movement—one easily mistaken for stillness, and usually seen, if at all, as blurr.

3. Short periods of slowing down of wing-speed, during which the wing-movement becomes again visible. (These are the "vibration" periods, representing to aeroplanists loose wing-trailing, or dragging like a flapping flag—an impossibility.) These periods often precede a special spurt such as is required to lift the fish over an oncoming wave.

4. Either sudden cessation of wing-movement and consequent immediate drop into the sea, or a short slow down into visibility (No. 3) previous to such drop.

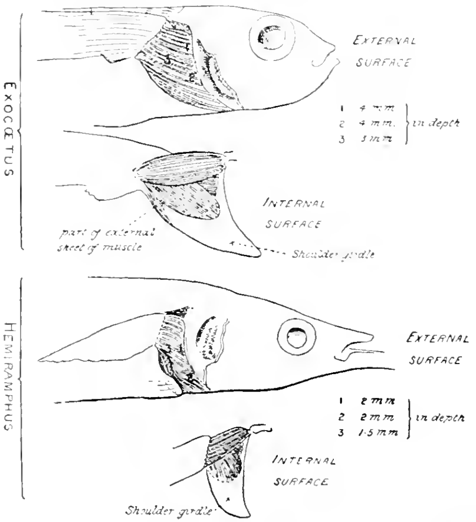


Diagram indicating relative fin muscles of flying fish and related species.

"It is to be noted that this vibration so often seen before the fish enters the water is one of the many pointers to continuous wing-movement, for such a time is a proper one for slowing down, but an absurd one for renewal of wing-effort. Mr. Adams has noticed the vibration of the wings as being in "an almost horizontal direction." This horizontal movement, if it exists, as is probable, may afford, as I hope to show, a looked-for key to the fish's action. According to Pettigrew, it is a necessity of flight, where wing-beats are in a more or less vertical direction, that the up-beat should meet with little and the down-beat with much resistance from the air. This is arranged for in the case of bats, birds, and certain insects by means of special muscles and ligaments, which automatically flex the wing for or during the up-stroke and extend it for or during the down. Marey (*Animal Mechanism*, p. 263, &c.: Int. Science Series, 1893) equally recognises the necessity for a diminished wing-area in the up-stroke, but believes it to be obtained in birds through the natural elasticity of the feathers, which enables them to return to their ordinary position when the resistance of the air in the down-stroke ceases to raise them. The flying fish's wing, as is known, is formed on quite a different principle from that of a bird or bat. It opens and closes somewhat like a fan. A partial automatic closing of this fan at the foot of the downward stroke in flight and opening at the top of the rising stroke would both give the appearance of horizontal vibration when seen either from above or below, and would turn a somewhat difficult question of the mechanics of the flight into a very simple one. Indeed, we have here flying action on the same general principle as that shown by Pettigrew and Marey to be necessarily provided for in the case of bats and birds, but the working details of which are different and simpler, as becomes a simpler form of wing. Perhaps that is the explanation. There must, of course, be some explanation, and that is not only the natural deduction from the peculiar formation of the wing, but it also fits everything in. The known (but indistinct) visibility of the larger rays of the wings at times during flight points, perhaps, to a comparative pause with wings full open before beginning the down-stroke. Such pause would give the open position, and with it the wing-tracery prominence. The form of these fishes' wings points to this fan-action rather than to other known horizontal wing-actions of the nature of that of certain insects—the common fly, for instance."

Lieut.-Col. Durnford adds to his paper a letter from Mr. Burne, of the Royal College of Surgeons, who dissected at the Museum the pectoral muscles of a flying fish with those of a nearly related non-flying fish :—
". . . . I have made a dissection of the pectoral muscles of a flying fish (*Exocœtus* sp.) and of a nearly related fish of much the same build, but without the enlarged pectoral fins (*Hemiramphus*). Both were specimens from our store-room, and although in pretty good condition had evidently been in spirit for a considerable time. I enclose you tracings of the drawings I made. The two of the external view were drawn with a camera, and the *Hemiramphus*, which was rather less in girth than the *Exocœtus*, was so much enlarged as to have the same girth about an inch behind the pectorals. I thought that body-girth sufficiently far behind the fins not to be influenced by their degree of development was the best standard of size to take—better than length, for instance. As a matter of fact, the fish were very much the same length, the *Exocœtus* being rather the longer.

"The drawings, I think, explain themselves. The flying fish muscles were, as you see, considerably larger, both in area and in thickness, than in *Hemiramphus*, and the same was the case with the muscles on the deep surface of the fin. In their arrangement they were much the same in both fish and the same as in other bony fishes (the cod, for instance). The numbers on the surface of the fins are the points where I took the thickness of the muscle by plunging a needle into it and measuring the depth to which the needle entered. You will notice the great length of the muscles in *Exocœtus*—a long muscle means a proportionate length of contraction.

". . . . there is a very marked difference in the size of the muscles of these two fishes. . . ."

"This tracing," observes Lieut.-Col. Durnford, "gives about $4\frac{4}{5}$ times greater bulk of muscle to the *Exocœtus* than to the *Hemiramphus*." With this light it will not be out of place to requote and amplify the one "proof," distinguishing the addition by italics :—"The pectoral muscles of birds depressing their wings weigh on an average one-sixth the total weight of their body, the pectoral muscles of bats one-thirteenth, the muscles of the pectoral fins of flying fish . . . . one thirty-second," *and the muscles of a nearly related non-flying fish only one hundred and fifty-fourth.*

"As before, it does not prove that bats or flying fish flap or do not flap their wings, but it gives a different and, I hope, a proper aspect to the figures which have done duty—of a kind—for so many years."

Light and the Visual Sense.

A Study in Biological Physics.

By Henry A. Fotherby, D.Ph. (Camb.), L.R.C.P. (Lond.), &c.

"The method by which a ray of light is able to stimulate the endings of the optic nerve in the retina in such a manner that the visual sensation is perceived by the cerebrum is not yet understood. It is supposed that the change effected by the agency of the light which falls upon the retina is, in fact, a chemical alteration in the protoplasm, and that this change stimulates the optic nerve endings."—(Halliburton.)

We know that the energy of light as well as heat and electricity are capable of producing chemical action. For instance, if a mixture of chlorine and hydrogen gases, which will keep indefinitely in the dark, is exposed to sunlight they will combine with explosive violence. The principle on which photography depends is the influence of light in producing chemical change in silver chloride, which becomes blackened owing to the reduction of silver. It is from the radiant energy of sunlight that chlorophyll, the green colouring matter of plants, derives chemical energy whereby plants are enabled to build up their tissues from the elements of carbon dioxide and water.

It has been observed that movements take place in the pigment granules of the retinal cells under the influence of light. The retinal cones also shorten in its presence and elongate in its absence. In the retinal rods of certain animals, notably frogs, there is a certain pigment called visual purple, which, though present in the dark, disappears in the presence of light, and reappears again directly the light is withdrawn. The visual purple is also found to undergo distinct changes of colour when exposed to other lights than white light.

It was on observations such as these that Hering based his theory of colour vision, consisting of six primary colour sensations, in opposition to the Young-Helmholtz theory of three only. The former suggests that these consist of three pairs of antagonistic or complimental colour sensations, black and white, red and green, yellow and blue, and that the stimulus producing each severally is caused by changes either of disintegration or assimilation taking place in certain three substances of the nature of visual purple, which it is assumed exists in the retina. Thus, in the case of the red-green substance, if assimilation is in excess of disintegration the sensation is red, if the reverse it is green, but when equal no sensation occurs. The Young-Helmholtz theory, on the other hand, teaches that there are only three primary elementary colour sensations—red, green, violet—and that the end-organs of the optic nerve in the retina, the rods and cones, consist of three varieties, each one specialised to respond to one of these three colour sensations, and that all the different shades of colour are due to the different degrees in which they are severally excited, the sensation of white being produced only when they are equally stimulated. This latter is the more generally accepted theory of colour vision. How these three colours, red, green, and violet, were selected and found to be the only fundamental colour sensations would take up too much space to describe here. It must suffice to say that it was due to a series of experiments by which the retina was exhausted for various colours, with the result that the fatigue manifested itself in these three colours, and it was found also that these three colour sensations could not be produced by any combination of other colour sensations.

The eye is not only a complicated optical instrument, but it is at the same time a vital organ of extreme delicacy functioned for the purpose of receiving sensory impressions of radiant energy, the velocity of whose radiations lie between certain definite limits, and transmitting them to the optic nerve centres in such a way that they can be translated into sensations of light and colour. It is owing to this fact that these rays have received the name of luminiferous ether. When the ether vibrations have acquired a velocity of 450 millions of millions a second they affect the retina and become appreciated as the sense of red; as the vibrations increase in velocity the colour sensations experienced are those of the solar spectrum from left to right, namely, from red through orange, yellow, green, blue, purple to violet, at which point the ether vibrations have reached the enormous velocity of 727 millions of millions per second. Beyond this point, what is technically called the ultra-violet portion of the spectrum is reached, where the vibrations become too rapid to be appreciated by the eye, and they consequently cease to be luminous. For example, "When a wire is heated in a spirit lamp placed in a dark room the particles of which the wire is composed are thrown into a state of violent vibration. As the heat increases the vibrations increase in rapidity. They are communicated to the ether, which surrounds and permeates everything; and the movements thus set up—infinitely small waves in this infinitely big ocean which fills all space—are sent off on their journey in all directions. At first the undulations are too slow to affect the retina, though they affect the skin. We perceive that the wire is hot if we hold it to our cheek an inch or two away, but our eye reveals no change. As the heat increases the rate of the waves increases, and when they reach to the enormous number of about 450 billions—that is, 450 millions of millions—per second, we see that the wire is glowing red. The ordinary physical cause of sight, then, is found in the fact that undulations or vibrations of almost inconceivable rapidity are affecting an organ specially adapted for receiving them, viz., the retina. . . . If we think this over we shall see that it involves the conclusion that what we call light does not exist in the universe apart from eyes to see it. The 'light rays' that physical science deals with are, in themselves, no more red or blue than the dark heat rays or than the X-rays of which we have heard so much of late; the sunshine would have no splendour, but from the eyes which see it. If eyes did not exist, the sun's rays would produce their beneficient effects on plants and animals just as they do now, but the splendour and beauty would not exist. They are due, not to the physical cause, but to the mysteries of a piece of living tissue, the retina, which has been given the power to select those rays composed of undulations of a certain degree of rapidity, and to somehow make them the occasion of mental facts of unspeakable beauty."—(Ryland. "The Story of Thought and Feeling.")

Having examined the nature of light and vision thus far, the question which naturally suggests itself is, how is the energy of light converted into a nerve impulse, and if, as seems probable, there are only three primary colour sensations, by what means are these severally differentiated?

The retina consists of several distinct layers of living protoplasmic cells, the most remarkable of which are the layer of rods and cones, which are found on the surface, and which, consequently, are the first to receive the impressions of incident rays of luminiferous ether. What happens in these cells under its influence? We know by examination of other tissues that protoplasm has the power of forming in its life processes certain bodies called ferments, which, under certain conditions and in the presence of favourable surroundings, produce chemical changes, either katabolic (destructive) or anabolic (constructive), without themselves being in any way affected. For instance, the gastric cells produce a ferment called pepsin, which is able to convert the proteids of food into peptones; so also the pancreatic cells possess a ferment called amylopsin, which is able to convert starches into sugar, with the evolution of various forms of energy, chemical, nervous, &c. Is it not possible, too, in case of the retinal cells, that the process by which the energy of light is converted into nervous energy may be a process of fermentation, and that the ions of luminiferous ether, acting on the ions set free by a ferment body present in these protoplasmic cells, may produce katabolic, and possibly anabolic, changes, which, liberating electro-vital force and nerve stimulation, are conducted by the piliments of the optic nerve to the visual centres in the brain, to be there interpreted by the consciousness as sensations of light and colour?

That light will produce these changes in the retinal cells is well illustrated by Waller's researches, and that the presence of ferment bodies in protoplasmic cells may, through ionic action, give rise to nerve force is supported by Dr. Allchin in a lecture given by him on "Nutrition and Malnutrition," reported in the *Clinical Journal*, April, 1905.

The former experiments are described in Halliburton's "Handbook of Physiology" as follows:—"The excised eyeball of a frog is led off by non-polarisable electrodes to a galvanometer. One electrode is placed on the front, the other on the back of the eye. A current of rest (demarcation current) is observed passing through the eyeball from front to back. When light falls on the eye this current is increased; on shutting off the light there is a momentary further increase, and then the current slowly returns back to its previous condition. Waller explains this by supposing that anabolic changes in the eye predominate during stimulation by light. With the onset of darkness, the katabolic changes cease at once, and the anabolic more slowly; hence a further positive variation. If the eyeball has been excised the day before the observations are made, or has been fatigued or injured, light produces principally katabolic changes, as evidenced by a negative variation. A slight positive effect follows when the light is shut off."

On the question of ferment bodies producing nerve energy, &c., Dr. Allchin expresses himself as follows:—"The vital activities of the living cells would seem to consist essentially in the formation of ferment bodies which alone, or in combination, effect those integrations and disintegrations which liberate chemical energy, and that this by transformation produces muscular work, nerve force, and secretory function, the fundamental manifestations of life. That these enzymes do bring about these changes in such conditions of temperature and alkalinity or acidity as obtain in the body appears to be certain, and as an explanation of the activity of the bioplasm, which elaborates these bodies, there is postulated an ionic action on the part of the cell contents, and their surrounding medium whereby charges of electricity of variable strength and character are brought into conflict, and that from the play of ions the manifestations of vitality result." Whether visual purple is of the nature of a ferment, as seems to be suggested by Hering's theory of colour vision, is not at present known, neither has its presence been demonstrated in the human retina as far as I am aware.

That ionic action should be produced by light in the presence of a ferment contained in the retinal cells would not be incompatible with the Young-Helmholtz theory of colour vision depending on three primary colour sensations, red, green, and violet, if we suppose that there are present in these cells three ferments capable of specially responding to each of these radiations (or one ferment even having the property of three separate reactions in an ascending scale of katabolism). It is important to note the position in the spectrum of these three radiations. On the extreme left are those which give rise to the sensation-red, of comparative long wave-length; that is, those which act least powerfully on the photographic plate; in other words, whose actinic or disintegrating powers are least powerful of the luminiferous rays; in the middle are those which give rise to the sensation of green, where actinic action occupies an intermediate position; whilst at the extreme right are those of shortest wave-length, which give rise to the sensation of violet. These are the so-called "actinic waves," whose actinic action is greatest, and which act most powerfully on the photographic plate.

Therefore, granting that in accordance with the Young-Helmholtz theory there are in the retina rods and cones which answer to each of these three primary colour sensations, and bearing in mind the above facts that the radiations producing them respectively occupy three fixed points in the spectrum, left, middle, and right, in an ascending scale of actinism (power to produce chemical change), I would suggest that an ionic action is induced by these radiations in association with three distinct ferments present severally in the rods and cones specialised to receive them, each ferment being specially capable of producing katabolic changes under the influence of the particular radiation concerned, and out of the energy thus liberated three corresponding degrees of nerve stimulation arise to affect the nerve cells in the deepest layer of the retina, which, on being transmitted by the nerve fibres to the nerve cells in the visual centres of the brain, are interpreted by the consciousness as the above colour sensations. The various other shades and colour effects seen in Nature are probably due, as the Young-Helmholtz theory teaches, to the different degrees of stimulation these three-colour terminals receive. Thus, if a large number of rods or cones, responding to the radiations to the extreme left of the spectrum, are brought under the influence of these rays, and those which respond to green and violet are hardly affected by their corresponding radiations, the sensation would be red. If, however, orange is the colour sensation produced, then it will be owing to the red terminals or rods and cones corresponding to red that are considerably influenced, the green rather more, and the violet only slightly so, &c. In bringing this paper to a close I must acknowledge my indebtedness to Watson's "Text-book of Physics," Ganot's "Popular Natural Philosophy," and Halliburton's "Handbook of Physiology."

Some Notes on the Giant's Causeway.

By EDWARD A. MARTIN, F.G.S.

THE wonders of the Giant's Causeway had drawn visitors to the Antrim coast long ere its geological importance was realised, and it may safely be said, even now, that not one in a hundred who visit it have any thoughts beyond those of mere curiosity, or consider for a moment how it came into existence, and what it all means.

Whitehurst, in 1786, was one of the earliest to understand the significance of its basaltic pillars, and his idea is still the accepted one, viz., that the rocks are the results of out-flows of lava from some volcanic centre or centres now hidden beneath the sea.

The Causeway proper is, of course, that portion which extends northward from the basaltic cliffs in the shape of a promontory towards the sea, beneath which it loses itself. But to the geologist, the whole of the five or six small bays to the east of it are full of interest, in consequence of the changes in the structure of the rocks, and the fact that regular columns of some kind or other are found throughout the whole, whilst the scenery to which they successively give rise is sufficient to attract numberless persons to whom geological facts are still as a sealed book.

The chief attraction in the Causeway is the large number of regular angular columns into which the lava has broken up. I use the words "broken up," advisedly, since there is no reason to believe that crystallisation has had anything to do with the formation of the columns. They have simply broken apart from one another, owing to the basalt, of which they

Fig. 1 The divisions between these columns are very clear and open.

are composed, requiring less room, so to speak, when cold, than it did when it was a melted mass.

As one walks or climbs over the heads of some of the columns, one cannot help asking oneself how far below they extend. If one looks at others which have been exposed in the cliffs, one can count safely on a length of about 20 feet, below which they probably would be found to close in upon one another and form a homogeneous mass of basalt, cracked and jointed irregularly, perhaps, but showing no columnar structure at all. The whole thickness of the lower basalts has been estimated as about 60 feet.

As we see the Causeway dipping beneath the sea, we shall realise the possibility of the basaltic flow following on, hidden from our view, until it joins that which appears in the Isle of Mull, off the west coast of Scotland. Professor Judd has stated that the Mull volcano must have been 14,500 feet high. A lava flow from such a volcano would be no small affair, and a historic parallel may be found in the flow in Iceland, in 1783, when it extended for 50 miles.

When lava is in a fairly viscid condition, the mass may contract on cooling without fracturing, but when

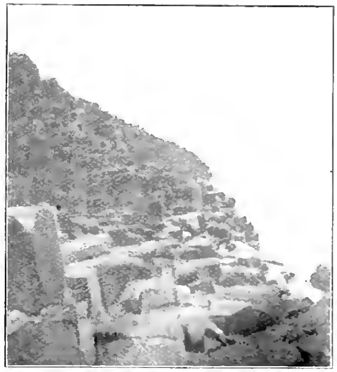


Fig. 2.—Tops of columns showing tilt to the west.

it is approaching more nearly to a solid condition, it cannot, as a whole, continue to contract. It must break up into smaller masses. When what has been called its "breaking strain" has been reached, the rock will exhibit a series of layers of increasing temperatures in a downward direction. In this way the surface and that immediately underlying will exhibit a "platy" structure, but below where this appearance is exhibited, there will be a region of lava, whence the heat is but slowly being conveyed away, owing to its bad powers of conductivity. Then a new set of strains appear. There must be contraction, and some part must give way and be fractured. The tension becomes greatest in a lateral direction, and fractures appear, reaching down perpendicularly to the direction in which the lava flowed. It is difficult, if not impossible, to say what conditions are necessary for the fractures to appear so regularly as they have in the case of the Causeway, or why, in other cases close by, irregular blocks with but a starch-like columnar structure only should appear. When the columns are regular, they are generally hexagonal, and often the sides are remarkably equal in length. Why the hexagon should be by far the commonest form has been a matter of much discussion. Professor Bonney states in this respect, that Mr. Mallet has shown that "there are only three regular forms into which plane space can be divided, viz., equilateral triangles, squares, and hexagons, and the amount of work which has to be done in producing these is given approximately by the ratio, 100 : 98 : 52. So the last of the three requires the least expenditure of force." It is stated with probable truth that 90 per cent. of the columns in the Causeway are hexagonal, and that only one triangular column is to be found there.

Although in certain groups the sides of the columns are fairly equal in size, there are many in which they are far from being so, whilst in many, one side may measure twice the size of the smallest side. They vary from about 8 inches to as much as a foot and a half. One of the unexplained phenomena in connection with the pillars is that the horizontal joints which divide them up into lengths of from 6 inches to two or three feet, do not always present strictly a plane surface, but the two portions fit into one another by either a con-

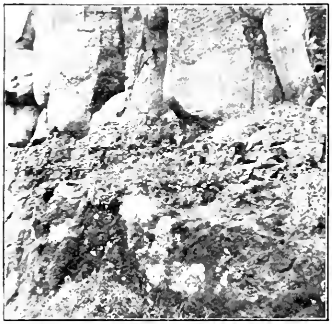


Fig. 3.—Irregular columns resting on shapeless basalt with red bole beneath.

cavity below and a convexity above, or *vice versâ*. Where the former has been the case, and the upper column has been removed, small pools of water collect in the concave top of the column.

Where the Causeway proper approaches the cliffs,

Fig. 4.—Rectangular and hexagonal columns. Note convex surface of hexagonal column in left hand bottom corner.

and the vertical sides of the columns show themselves *en masse*, the weathering of the joints is very noticeable, so that the sharp angles are lost and the different portions of the columns have acquired a rounded aspect, and have begun to assume a bomb-like appearance. This is particularly noticeable on the spot whence the illustration (Fig. 6) is taken, situated at the east end of the sixth of the little bays which collectively go to make up the Giant's Causeway, in the broadest use of the term. These are not, however, true volcanic bombs, but are merely harder, rounded blocks, from which the matrix in which they were wrapped has decayed.

The rocks which form the whole of the cliffs are divided into two principal lava-flows, and these are known respectively as the Upper and Lower Basalts. Between the periods represented by these two great flows, sufficient time elapsed to allow of great changes taking place in the upper portion of the earlier flows. This has resulted in the appearance of a great thickness of "red bole," a hydrous silicate of alumina, although thinner bands of the same rock occur between the successive minor flows, which go to make both the Upper and Lower Basalts. The illustrations (Figs. 3 and 5) show the lower ends of columns of rather irregular structure, which must have formed deep down in the upper lava flow. They rest upon the broken basalts, in which the fractures took no regular structure, and this in turn rests upon the thick red bole between the two chief flows. Westward from this, the base of the Upper Basalt descends to below sea-level.

One little promontory which juts out and so divides off the areas of two little bays appears to have resulted

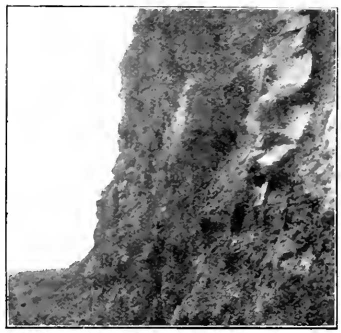


Fig. 5.—Bomb-like concretions in basalt.

from having a backbone of harder igneous rock than the rest, and this must have flowed through a crater, or "neck," as we should now call it, that had opened out in a fracture in both the Upper and the Lower Basalts. This, indeed, may have been one of the fissures which fed the supply for the later of the Upper Basalts. How far back into the land away from the coast this neck extends has not been determined, but many of the fissures, in other places, through which lava has poured extend for many miles. Such a one is the great Cleveland Dyke, extending across the surface of Yorkshire. They are plentiful in south-west Scotland, and those who know the Biological Station at Millport, Greater Cumbrae, will recognise in the "Lion Rock" one such dyke, and in the great wall on one side of the Station grounds another. The latter can be traced into the cliffs at the back, and under foot, down to the shore in front. It is only about 3 feet wide, but has stood atmospheric denudation to a much greater extent than the Old Red Sandstone rock, into whose fissures the lava welled up.

Not the least interesting phenomenon in connection with volcanic dykes is the manner in which they have affected the strata which they have pierced, and the effect on the strata may be regarded as a criterion as to whether the infilling of a fissure is actually a dyke or no. On the road between Portrush and Port Ballintrae, near Dunluce Castle, one passes what must at one time have been a great crack in the chalk, and this is filled with volcanic materials. But one looks in vain for any signs of metamorphism of the chalk, other than that which occurs throughout the district, and it is doubtful whether this is anything but an agglomerate, that is, a filling-in of volcanic materials, probably brought into the fissure from above. As a rule chalk and other

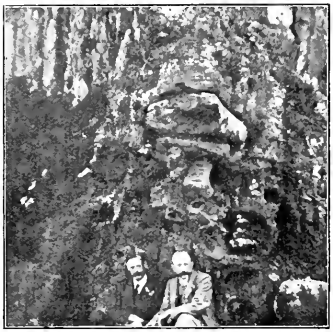


Fig. 6.—Weathered bomb-like concretions in the cliffs.

limestones have been changed for some few inches on each side of a dyke into a marble, often highly crystalline. Sir Archibald Geikie mentions such a case as occurring in Templepatrick Quarry, Antrim, where for some six inches on each side of the igneous rock the chalk has assumed a finely saccharoid condition, whilst its organisms have been effaced. Within a foot of the dyke the chalk has assumed its usual character, and the

Fig. 7.—Columns at top of cliffs. Between the two central masses was a later volcanic vent.

microscopic organisms of the chalk are again discoverable. All who know the chalk cliffs of the Antrim coast, such as those, for instance, which occur at the picturesque but neglected little fishermen's port of Ballintoy, where there is the maximum thickness of about 250 feet of chalk, will remember the indurated rocky character of the chalk, but this occurs far away from any lava filled fissures. It is usual to attribute this induration to the baking process caused on the out-pouring of the lower basalts over the plateau. If this be the direct result of the operation it seems strange that the included fossils remain so apparent as they do; whilst seeing that the contact metamorphism of the chalk extends for but a few inches on each side of a dyke, it is difficult to see in those great thicknesses of indurated chalk beneath the basalt the direct effects of the heat given out from the lava. It was suggested some years ago by Mr. E. R. Sawer that chemical action resulting from the percolation of thermal waters may have played a considerable part in this induration of the chalk where unaffected by dykes, and there is much to be said in support of his contention. It is pointed out that in the Caucasus, the chalk, although it is covered by great sheets of andesitic lavas, still retains its usual friable character, whilst on the other hand, in the Crimea, indurated chalk occurs similar to that at Antrim, but without any signs of having been affected by igneous rocks. Possibly, by the way, in the suggestion of hydrothermal action we may see the origin of what is known in the south of England as the "chalk rock," on the *Holaster planus* zone of the chalk.

Sandstones, when pierced by igneous matter, have been changed into a kind of quartzite, and this has

Fig. 8.—Basalt rocks off the coast showing dip to the west.

even assumed a columnar structure. A similar structure has sometimes been taken by clay and shale in similar circumstances, instances occurring at Strath, in Skye, and in Derbyshire, at Tideswell Dale. Geikie mentions that in the Ayrshire coal-field, a mass of intrusive basalt has resulted in the coal in contact with it being changed into a finely columnar coke. But in all cases the actual distance to which metamorphism has taken place is to be measured in inches only, and contact metamorphism requires a supplementary agency where the effect is found over large areas.

Sectional Ruled Paper Pads. Messrs. W. and A. K. Johnston, Ltd., have sent us some pads of sectional paper, such as can be used for plotting mathematical curves, as well as for astronomical and other scientific purposes. The sheets are of two sizes, $8\frac{1}{2}$ inches by $10\frac{1}{2}$ inches; and $5\frac{1}{4}$ inches by $8\frac{1}{2}$ inches, and are ruled either in millimetres or in inches, and fractions of an inch.

TO OUR READERS.

The "Knowledge" Book Club.

We would beg to call the attention of all regular readers of this journal to our new scheme of instituting a library of scientific works for the use of subscribers. This should, we believe, supply a long-felt want. Those interested in scientific pursuits are frequently handicapped by not being able to get hold of the particular book that they want, either because they have a difficulty in finding out what is the most suitable work for their purpose without seeing it, but more especially because, when found, that work often proves to be one of considerable expense, and hardly worth buying if only required to look up some special detail. Moreover, when working up a scientific subject, it is usually not only desirable to read some one work, but many different authorities should be consulted in order to get at what has been done in that subject. It would, as a rule, be quite out of the question to buy all these books; to merely dip into them when found in some public library is unsatisfactory; and technical books are seldom to be got in an ordinary lending library. But when a good catalogue can be consulted, a list of the required books made out and sent to the office, and the actual books forwarded at once to the home of the reader, to be retained any reasonable time, and then exchanged for others as often as desired, then one gets what may be called the acme of literary comfort. Even though one may have the use of other libraries it is just as well to belong to this (at so little extra cost), as, if the desired book is not procurable at one library, it may be in the other. In forming this library it is our intention to supply *any* book, regardless of price or date. This may be a difficulty, especially at the start, many works being scarce and not easy to procure at short notice, but we have already been purchasing a number of the older and standard works, and hope before long to have a very complete collection.

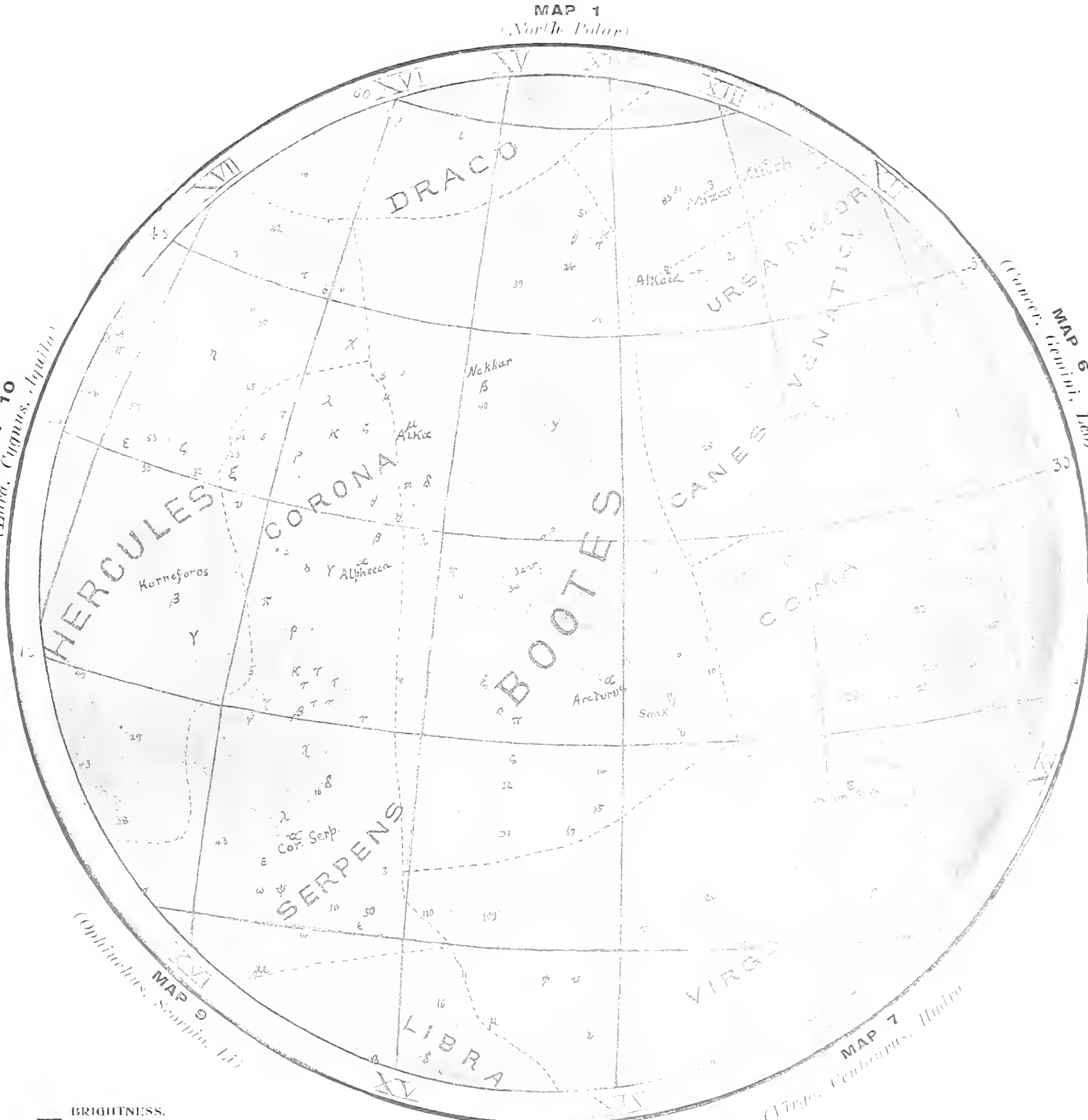
We feel sure that the majority of our readers will appreciate this institution, but they can, of course, hardly expect that the profit to be got out of a small sixpenny paper can be sufficient to start and maintain a good library, especially considering the uncertainty of the number of subscribers. We therefore propose to charge an entrance fee of ten shillings to cover the expenses of registration and of arranging the library and compiling the catalogue (which will be supplied free to subscribers). Extra volumes can be had at a reduced rate. Beyond this there will be no charge above the ordinary subscription rate. This, it must be recognised, is but a moderate charge, seeing that the total subscription to be paid, including the entrance fee and supply of the journal, is far less than what is charged at ordinary lending libraries, and but a fraction of the subscription which includes the delivery of a daily paper. We do not expect to clear any profit by this means, but hope to considerably increase our circulation, and so reap profits in other directions. Subscribers will, therefore, get the greatest benefits from this arrangement, and provided that a good proportion of our present readers join, and that we get a reasonable support from outside, we can guarantee that the book club will prove of great assistance to them.

But it will readily be comprehended that to make this book club a real success, not only from our point of view, but from that of the reader, a large number of subscribers is necessary. To make this clearer, let us suppose that each subscription enables us to get one book. Then, if one hundred readers joined, we should be able to provide a hundred books. This would give but a very limited choice. If a thousand joined we could have every scientific work published during the last few years. But if five thousand sent their subscription we could supply, on the average, five copies of each of such works, or, since many of the older books would not be much sought after, perhaps one hundred copies of a few popular ones. Then all subscribers would be sure of getting a copy of the desired book at once. So we sincerely hope that all who see the benefits to be derived from this establishment will give it their support. Even those who have no immediate need for the use of the library may at any time find that they wish to use it, and as it involves no payment beyond the entrance fee, no extra expense need be incurred by joining now instead of later on.

Resulting from the notice published in last month's "KNOWLEDGE," several applicants, who obtain their journal through a bookseller, have written to know if it would be possible to join the book club. Seeing that, for the support of the library, we are relying almost entirely on the very small profit derived when copies are bought direct and not through the trade, this would be impossible without extra charge. We will, however, gladly oblige anyone who likes to add to his subscription the difference between the wholesale and the retail price.

As regards the *sale* of books, it is not the intention to found a book-shop and attempt to rival old-established businesses. At the same time, arrangements will be made so that a reader wishing to retain as his own any book he may have obtained from the library, can do so on payment of the ordinary value of the book.

Each month a catalogue of additions to the library will be published in "KNOWLEDGE," and this will add greatly to the usefulness of the club as compared to other libraries.



BRIGHTNESS.

- 1st Mag.
- 2nd „
- 3rd „
- 4th „
- 5th „
- 6th „
- Variable
- Nebula

MAP No. 8.

Corona. Bootes. Coma.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Opacity Measuring Apparatus.—The *British Journal of Photography* (page 873), quotes from the *Revue des Sciences Photographiques*, the description of an "Opacity Comparator," by M. Monpillard, which is illustrated by M. Nachet. This instrument is so similar to my "Opacity Balance," that I described in 1899 (Journal of the Royal Photographic Society, xxiii., 99), that it may justly be regarded as a modification of it. In both an incandescent gas mantle is the source of light; two mirrors give two beams of light, so that the plate to be measured may be interposed in the path of one; these two beams impinge on opposite sides of a prism and so are reflected into the eye-piece for observation. So far as the instruments differ, I believe mine to be the more advantageous and less costly. But my main reason for referring to this matter is that M. Monpillard claims that his instrument will do what it cannot do. He makes the same mistake that has misled many investigators both in England and on the Continent, in neglecting the light that is scattered by the silver deposit in the negative, or at least neglecting an unknown part of it, while this scattered light forms a considerable and variable proportion of the light transmitted, variable even in the different densities of the same plate. The claim, therefore, that such an apparatus will give "the absolute value of the density," is quite in error. I have found that by neglecting this scattered light the "density" readings may be increased from twenty to forty per cent. or more, when measuring ordinary plates, and up to as much as three hundred per cent. if the deposit is bleached. The chief claim that I made for my opacity balance was that it serves to quickly and accurately compare the deposits of the same density on any one given plate.

M. Monpillard has adopted a pinhole aperture in his eye-piece, to avoid parallax when viewing the final reflecting prism, to compare the beams of light reflected into the eye-piece by its opposite sides. I tried modifications of this method, and although it is quite practicable, it is so difficult to keep the eye central while attending to the matching of the two beams, that I substituted a small plaster plug on the surface of which the two beams fall side by side and in actual contact. This method entirely gets rid of the difficulty, and serves for all the opacities generally met with, when using an incandescent gas mantle. The direct observation method is available, if required for very high densities, by merely withdrawing the plaster plug and putting in an eye-piece. M. Monpillard's apparatus will give an aperture 3 m.m. wide for the measurement of spectra, but I regularly use an aperture of one millimetre and can easily reduce this to one half the width or less if desired. I cannot see, therefore, that M. Monpillard has modified my instrument in any way to advantage.

Depth of Field in Lenses.—In the photography of solid objects it is obviously necessary to get sufficiently good definition, at the same time and on a flat plate, of objects at different distances from the lens. Theoretically, perfect definition in the same plane of objects at different distances is impossible, but as no lens is theoretically perfect, so that a point in the object always gives an image of measurable size, and which is greater when the object is not at the exact distance focussed for, this becomes a purely practical matter. It is first necessary to determine the extent of surface that the image of an absolute point may be allowed to cover. Of course, this must vary, and vary largely, according to circumstances, but for purposes of calculation, a disc the one-hundredth of an inch in diameter is the accepted standard in this country, and a disc one-tenth of a millimetre (or the two-hundredth-and-fiftieth of an inch) is the Continental standard. For small work the English standard is too large, while the other is often too difficult to realise, and unnecessarily small for work even of moderate size.

The hyperfocal distance is a constant that is of much use in this connection, and may be described in various terms. If a lens is focussed on an object that is so far away that the image produced by the lens is not a measurable distance from the principal focal plane of the lens, the hyperfocal distance is the distance from the lens of the nearest object that the lens will define without exceeding the adopted standard. Then objects between the hyperfocal distance and infinity are defined without transgressing the standard of definition. If, instead of focussing on a very distant object, the hyperfocal distance itself is focussed on, then the distant object will be just well enough defined, and there will be also a considerable range of distance nearer the lens than the hyperfocal distance which will also be defined within the accepted standard. For practical purposes this nearer limit may be considered as half the hyperfocal distance. If, for example, the hyperfocal distance is thirty feet and the lens is focussed on an object thirty feet away, all objects from about fifteen feet to the horizon (or infinity) will be defined within the standard.

Methods of Calculating the Hyperfocal Distance.—The hyperfocal distance is directly proportional to the focal length of the lens and the diameter of its aperture, and inversely proportional to the diameter of the permissible disc of confusion. The usual formula for calculating it is therefore $H = \frac{fd}{c}$, where H is the hyperfocal distance, f the focal length of the lens, d the diameter of its aperture, and c the diameter of the maximum permissible disc of confusion. If the aperture is expressed in the usual way as a fraction of the focal length ($f/8$, &c.), representing the denominator of the aperture fraction as a, the formula becomes $H = \frac{f^2}{ac}$. If the focal length is measured in inches, and the disc of permissible confusion is taken at one-hundredth of an inch, then for the hyperfocal distance in feet, $H = \frac{f^2 100}{12a}$. Dr. Lindsay Johnson has recently pointed out, and it has been pointed out before, that for an aperture of $f/8$, the denominator is so nearly 100, that, for this aperture and disc of confusion, the error is negligibly small if the formula is written $H = f^2$. That is, the square of the focal length in inches is the hyperfocal distance in feet. The effect of changing the aperture is easily calculated, the hyperfocal distance being directly proportional to the aperture diameter. (At $f/16$ it will be the half of what it is at $f/8$, at $f/32$ a quarter, and so on.) Dr. Lindsay Johnson also points out that the hyperfocal distance may be calculated exactly in Continental units, the diameter of the disc of confusion being taken as one-tenth of a millimetre, by multiplying the focal length in centimetres by the diameter of the aperture in centimetres, the resulting figure being the hyperfocal distance in metres.

Such figures, like almost all other figures connected with lenses, are not of the absolute value that they might be supposed to be from the way in which they are often referred to. They assume that the lens is free from every aberration, and even then do not include the effect of the obliquity of the rays that fall upon the plate everywhere except centrally opposite the lens. They are serviceable for all good lenses in the middle of the field, and so far as the field is flat and the defining power of the lens does not fall off. With the larger apertures of a "rapid rectilinear" lens, this will be a very small area of the plate that it is supposed to cover; with a modern anastigmat it will be of greater extent, but lenses of both classes vary very much in quality.

CORRESPONDENCE.

A System of Applied Optics.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

DEAR SIRS,—While feeling highly gratified by the kindly and appreciative review of the above work which appeared in your November number, I would like to point out that I do not introduce an altogether new convention as to signs, as your reviewer implies. In fact, I have always arranged my conventions in entire accordance with those adopted by Coddington, in 1829, in his own work, and which have always struck me as the most practically reasonable sign conventions that have yet been put forward among the various writers on optics, all other methods being too abstract and academical.

Yours, etc.,

H. DENNIS TAYLOR.

York, November 16, 1906.

N Rays.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

DEAR SIRS,—I should be obliged if you could tell me whether any investigators other than M. Blondlot, have obtained indications of the supposed N radiation. What do physicists in general think with regard to Blondlot's results, and his belief in his discovery?

P. M. RYVES.

Zaragoza.
October 19, 1906.

[Results partly subjective; in so far as they are objective probably N rays are long heat-waves. General attitude sceptical. A.W.P.].

A Curious Optical Effect.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

Dear Sirs,—The explanation of the above-mentioned by "B." in your last issue, is, I take it, comparatively simple and would constitute a good "Exam." question for students in optics and sight testing. The clear perception of a line at any angle depends on the relative curvature of the various meridians of the eye. Generally, the cornea of the eye has less curvature in the horizontal than the vertical meridian, and, as a consequence, the diffusion patches which form the total image of a line overlap on themselves in the horizontal meridian, with the result that the margins of the line remain clear and distinct, whilst those in the meridian at right angles overlap the margins, causing them to be indistinct. If the diagram is looked at with the page held horizontally, a reverse effect will be obtained. It is, perhaps, unnecessary to say that this defect is known as astigmatism, and that Sir G. Airy was one of the first persons to notice this defect of the eye, being astigmatic himself.

Yours truly,

W. BANKS.

Bolton.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Physical Investigations of Sun Spot Spectra.

MESSRS. HALE, ADAMS, AND GALE have recently published the results of a long investigation on the causes determining the chief phenomena of sun-spot spectra, giving comparisons with similar variations of the spectra of terrestrial substances treated in different ways in the laboratory. One of the chief experiments consisted in volatilising the elements most important in sun-spot spectra under two or more degrees of temperature, produced by electric arcs of 30 and 2 ampères respectively, and by the electric spark. Tables are given of the lines of Titanium, Vanadium, Iron, Chromium, and Manganese, extending from the ultra-violet to λ 5800, showing their varying intensities when subjected to these different heat sources. The main results show that over ninety per cent. of the lines, which are strengthened in sun-spots, are found to be strengthened in passing from a 30-ampère arc to a 2-ampère arc. Also, of the lines weakened in sun-spots, over ninety per cent. are weakened or absent in the 2-ampère arc.

Over ninety per cent. of all the *enhanced*, or special spark-lines, are weakened or absent in the 2-ampère arc. From many collateral results it is generally considered that the temperature of an electric arc decreases with decreasing current strength, so that the above conclusions certainly point the suggestion that sun-spots are regions of lower temperature than the surrounding photosphere.—(*Astrophysical Journal*, xxiv., p. 185, October, 1906.)

Jupiter's Seventh Satellite.

The seventh satellite of Jupiter has been again observed by Professor Perrine, at the Lick Observatory. The co-ordinates of the observed position were :—

Position angle	= 119°.1	1906 September 25.9962
Distance	= 257.8″	G.M.T.

Cape of Good Hope Observatory Report for 1905.

In his report on the work of the Cape Observatory during 1905, Sir David Gill gives special prominence to the progress made with the new transit circle. Some trouble has been experienced with the completion of the new underground azimuth marks, but the pits are now water-tight and the lenses mounted in position. Observations have been regularly made with the new system since October 31, 1905. For the adjustment of the marks in relation to the long focus collimating lenses, a new method was devised to get over the difficulty of bringing a spider web into coincidence with its own reflex image, and this is said to give an error of only ± 0.01″ for a single pointing. An important point brought out by this method of observation is the systematic diurnal variation of the azimuth of the transit circle between sunset and midnight. Although the discussion of the observations of circumpolar stars is not yet sufficiently advanced to determine the absolute variation of the azimuth marks, the opinion is expressed that they may prove sufficiently stable to determine the horizontal component of the Chandler change of latitude. The chief drawback is the frequent apparent unsteadiness of the marks, produced by irregularities of refraction in the intervening air, and it may ultimately be desirable to protect the intervening ground from the sun's rays.

The new transit circle has been in regular use during 1905, all transits having been observed with the Repsold travelling wire, without clockwork, but an apparatus has now been supplied by means of which the wire is driven electrically across the field.

The new sidereal clock has now been provided with the air-tight enclosure, in which the air is kept uniformly about 75° F. by means of a thermostat; the temperature and pressure control are now regarded as perfect.

Publications.—The printing of the Cape Catalogue of 8,500 Astrographic Standard Stars has been completed, and the MS. of the Cape General Catalogue for 1900, including 4,300 Stars, has been passed for press.

Victoria Telescope.—The spectroscope has been under repair during a considerable period, and the telescope used for photography of star clusters, nebulæ, and the photographic observations of the satellites of Saturn and Uranus. Fifty-four negatives of stellar spectra have been measured and reduced for motion in the line of sight.

100-inch Mirror for Mount Wilson Observatory.

Just as the astronomical world is awaiting with special interest the account of the performance of the new 60-inch mirror made by Professor Ritchey, the munificence of Mr. J. D. Hooker, of Los Angeles, has enabled Professor Hale to arrange for the construction of a still larger reflector. This is to be 100 inches (2.54 m.) in diameter, and 13 inches (33 cm.) thick. The focal length is to be about 50 feet. The disc of glass will in all probability be furnished by the Plate Glass Company of St. Gobain, and the grinding and subsequent optical finishing will be done by Professor Ritchey at the Solar Observatory. The block of glass will weigh four and a-half tons, and it is estimated that the instrument may be completed in about four years. It is stated that the method of parabolising which Professor Ritchey has perfected quite eliminates the necessity of any hand work in obtaining the final figure. One of the chief difficulties anticipated is the disturbance caused by temperature changes, but as the instrument will be chiefly for use at night, means will be provided to keep the whole cool during the daytime by refrigerating machinery. Regarding the prospective working programme for this new leviathan, there are frequent calls for adequate spectroscopic study of stars beyond the reach, on account of their faintness, of existing instruments. Researches on the red stars, photography of small spiral nebulæ, minute study of the structure of the large nebulæ, investigations of stellar spectra with high dispersion, will all be greatly advanced by the facilities afforded by the greater light-gathering power.

Recent New Comets.

Comet g (1906).—This was announced by telegram from Kiel. The object was discovered at Copenhagen, on November 10, its position then being:—

	h.	m.	s.		d.	h.	s.
R.A. =	9	16	3·2	1906 November	10	17	3·5
Decl. =	+ 12	28′	31″ (N).	(Copenhagen Mean Time).			

The daily movement in R.A. was given as 4.2ᵐ, and in Decl. + 1° 10′, from which it will be seen that the comet was then travelling in a north-easterly direction.

A later telegram announced that the comet had been observed from Vienna on November 11, in the position:

	h.	m.	s.
R.A. =	9	20	9·5
Decl =	+ 13	35′	25″ (N).

From observations made November 10, 11, 12, and 13, various elements have been computed, a selection of which is given below.

ELEMENTS.

	Herr Ebell.		Prof. J. Franz.		Duncan & Williams.	
T	1906, Dec. 7·8350		Dec. 15·168		Dec. 12·45	
ω	354	20·6	34	46·8	31	34′
Ω	82	7·1	86	34·9	80	26
i	46	12·2	71	48·7	69	52
log q.	0·07119		0·05560		q = 1·153	

EPHEMERIS.

	R.A.			Decl.	
	h.	m.	s.		
1906 Dec. 2	12	1	32	+ 46	4·2
6	12	56	27	+ 51	0·0
10	13	50	38	+ 53	52·8

Comet h (1906).—This was discovered by Metcalf, at Taunton, on November 14.

	h.	m.	s.		d.	h.	m.
R.A. =	4	4	6	November	14	10	0·4
Decl. =	— 2	16′	(S).	(Taunton M.T.)			

It was observed later by Hammond (?) at Washington on November 16.

	h.	m.	s.		d.	h.	m.
R.A. =	4	4	11·45	November	16	11	35
Decl. =	— 2	46′	55″ (S).	(Washington Mean Time.)			

Motion, south-westerly. Position at discovery about half way between 35 and ξ Eridani.

BOTANICAL.

By G. MASSEE.

The Karroo Vegetation in August.

THE Karroo is a broad, elevated tract of country, situated in Cape Colony, which extends from the Ceres district on the west, to nearly as far as Grahamstown on the east. The altitude varies from about 1,800 to 3,000 feet. It is bounded on the north and south by mountain ranges. The rainfall is small throughout the area, in fact, in some parts a whole year may occasionally pass without rain; the daily range of temperature is very considerable. These marked climatic conditions are such that the vegetation is of a desert or semi-desert character.

A characteristic portion of this area, near the tiny village of Matjesfontein, about 200 miles distant from Cape Town, was investigated by Weiss and Yapp during the month of August. The plain, as far as the eye can reach, is covered with low bush or scrub. At a distance the scrub often appears to be continuous, but a nearer view shows it to be an open one, a considerable amount of bare ground being visible. The shrubs possess many features in common, having, for the most part a rounded outline, are richly branched, and usually possess inrolled, heath-like leaves. The prevailing colour is a dull greyish green. In the dry channels of water-courses, often not more than one inch deep and a foot broad, evidently formed by the rush of water during heavy rains, and also in certain low-lying patches where the rain had soaked into the ground, were observed patches of plants that were absent from neighbouring less-favoured and drier situations. Pretty little annuals occur under the shelter of larger bushes, etc., flowers and fruits being met with on seedlings only one or two inches in height, and on which the cotyledons are still fresh and green. The adaptation these ephemeral plants exhibit to a dry climate turns on the short duration of their lives, a single shower being sufficient to enable them to pass through the whole cycle of their development.

In comparison with other desert areas, succulent plants, along with bulbous or tuberous plants, form a very marked feature of the Karroo. Such plants, whether furnished with fleshy roots, tubers, bulbs, and other subterranean water-storage organs, spring up abundantly after the rains. Many of the Karroo plants, in common with those of other desert regions, are spiny. A noticeable feature was the spiral twisting of the leaves of many Liliaceæ and allied families. Sometimes each leaf is twisted independently, in other instances all the leaves are twisted or spirally coiled together. The majority of the flowers had a strong, sweet perfume. Probably the great majority of perennial plants, which are usually deep-rooted, depend largely on subterranean sources for their water supply. Other plants possess two distinct root-systems. One strong tap-root, which descends, and probably taps a subterranean water supply, while the other system consists of branches given off from the main root, and spread horizontally just under the soil. This last system probably collects water from slight showers, or from the heavy, nightly dews.

Lichens are most conspicuous amongst cryptogamic plants. A few ferns, mosses, and even liverworts, occur in shaded situations. The vegetation of the Karroo is represented by over 1,000 species, included in some eighty-four natural orders. The order Compositæ is the most conspicuous family, not only as regards numbers of species and of individuals, but also in the great variety of habit and adaptation to exceptional conditions.

Coloration of Wood by Fungi.

Independent of the discoloration of unpainted and sawn wood due to dirt, oxidation, etc., certain other stains of various colours are also often present, more especially on newly-sawn wood. The stains may be blue, brown, black, pink, purple, and yellow. These discolorations have been found to be due to fungi, by Hedgcock, who states that in the United States much injury is done to boards of pine, gum poplar, and other kinds. The blueing of the wood of the western yellow pine is caused by *Ceratostomella pilifera*; this blue stain of pine-wood has long been known in Europe, where it is caused by the same fungus.

The stain caused by species of *Ceratostomella*, *Graphium*, *Hormiscium*, and *Hormodendron*, is due to the dark-coloured mycelium permeating the substance of the wood; no stain exudes from the mycelium. In species of *Penicillium*. The discoloration is due to a yellow or red stain from the mycelium, which is taken up by the wood. These stains fade when the wood dries, but reappear when it is moistened. This discoloration caused by *Fusarium* is partly due to the presence of a soluble stain secreted by the fungus, and taken up by the wood, and partly to the presence in the wood of coloured mycelium.

No mention is made of the brilliant verdegris green colour of wood of ash, oak, etc., caused by the equally brilliantly coloured cup-shaped fungus, called *Peziza æruginosa*, so common in this country, and from which various articles are made, and known as Tunbridge ware. Presumably this fungus is rare or absent from the United States.

Leaf Variation in Coprosma Baueri.

Some remarkable changes in form of the leaves of this common New Zealand shrub are recorded by Dr. Cockayne. When growing wild on wind-swept cliffs by the sea, where it may receive at times a certain amount of sea-spray, the leaves are fleshy, glossy green on the upper surface, much paler beneath, and the margins recurved. This latter character is sometimes carried to such an extent that each half of the blade is rolled round itself, or the one half may be rolled round the other, the leaf thus presenting the appearance of a cylinder. The size of such leaves varies to some extent, but an average is 3.2 cm. by 1.9 cm. As *Coprosma* is amendable to cultivation, it is commonly used for hedges, and when grown in fairly sheltered situations, away from the influence of the sea, the leaves are much larger, thinner, not quite so glossy as those of wild coastal plants, and quite flat. An average size of such leaves is 12.3 cm. by 9.7 cm. If the upper portion of a cultivated hedge happens to be exposed to wind, the leaves show a tendency to curl, the amount of curling being in proportion to the amount of exposure to wind.

New Ferns from New Zealand.

Two new ferns are described by Field. in *Trans. N. Zeal. Inst.* One, named *Doodia aucklandica*, is allied to *D. media*, from the same country, differing in having a more compact habit and other important features. The second is named *Pteris novæ zelandiæ*, most nearly resembling *P. tremula*. The author considers that cresting arises from plants growing under some peculiarly favourable conditions, as in several instances specimens become so under cultivation. When a plant breaks into cresting, seedlings from it are apt to exhibit the peculiarity in an exaggerated form.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Bleaching of Flour.

NUMEROUS methods of bleaching flour have been devised (see "KNOWLEDGE & SCIENTIFIC NEWS," Vol. II., p. 86; Vol. III., p. 503), but according to the investigations of M. Fleurent the only processes that have any industrial value are those in which nitrogen peroxide is used as a reagent. Pure oxygen or ozone does not affect the colour, and although ozonised air has a bleaching effect, this is to be attributed solely to the nitrous vapour with which the gas is charged. Moreover, flour treated with ozone acquires a disagreeable odour, which destroys its commercial value. In the bleaching with nitrogen peroxide, the oil in the flour combines with the gas, and the weight is increased. This fact affords a means of detecting bleached flour in untreated flour, for on extracting the oil with petroleum spirit, and converting it into soap, the product has a brownish red colour if nitrogen peroxide had been used in the bleaching, whereas the soap solution from an unbleached flour is pale yellow. The intensity of the red colour is proportional to the amount of the nitrogen peroxide that has been absorbed by the oil; and M. Fleurent finds that the test is capable of detecting five per cent. of a bleached product in ordinary flour. The oil in bleached flour becomes acid less readily than in the case of ordinary flour, and it is in this sense only that the bleaching process can be said to have any "preservative action."

An African Arrow Poison.

Dr. Bolton has communicated to the Royal Society the results of his examination of a recently discovered arrow poison, obtained from Ghasi, a town in Northern Nigeria. Dr. Alexander, who forwarded the poison, states that in the fresh condition it is a semi-fluid, black, sticky substance, consisting of or containing the juice of a certain species of fig. It is smeared on sticks, and when required for re-dipping arrows is scraped off and heated. The poison received in London was spread on the ends of two canes, and dusted over with powder from the inside of a gourd. It was a soft, black paste, with a peculiar sweet smell. It dissolved readily in water, with the exception of a small portion consisting chiefly of starch granules. The solution filtered from the insoluble matter was transparent and dark brown, and had a slight acid reaction. The poison was not affected by boiling, and was thus not a true toxine. It acted upon the muscular tissue, and did not appear to have any effect upon the central or peripheral nervous system. Death results through the direct action of the poison upon the muscular system. So potent is the poison that Dr. Alexander reports that a native shot with a poisoned arrow was dead within 25 minutes. The chemical nature of the active principle has not yet been determined.

Protecting Iron with Paper.

A new and valuable use for paper has been discovered by Mr. L. H. Barker, in the course of experiments on the methods of protecting iron and steel structures against the action of moisture and atmospheric corrosion. When coats of various kinds of paint were found to be ineffective, trials were made to determine the protective power of paper impregnated with paraffin wax. The iron was first thoroughly cleansed from rust by means of wire brushes and a coating of sticky paint applied. The paper was then pressed tightly on to the surface of the fresh paint, with the edges made to overlap somewhat, and coats of paint at once applied to the surface of the paper. It was found that iron and steel thus protected remained in the same condition as at first, after constant exposure for 27 months to the action of smoke, while the sticky layer of paint on the metal was also intact, and in some places still not dry. It was also proved that steel treated in this way could remain in contact with moist air and sewer gases without its surface being in any way attacked.

The Amount of Alcohol in Bread.

The fact that, in the process of leavening, flour is made to undergo a restricted fermentation, suggests the probability that the finished loaf may retain a small amount of alcohol which has not been expelled by the heat of the oven. This supposition was confirmed by Herr Balas, who found that freshly-baked English bread contained from 0.2 to 0.4 per cent. of absolute alcohol. His assertion has recently been investigated by Herr Pohl, who has distilled large quantities of two kinds of German wheat bread with water, and examined the distillates. In every instance he has detected alcohol, though in smaller quantities than those found by Herr Balas, the proportions ranging from 0.05 to 0.08 per cent. In addition to alcohol, the distillates also invariably contained a small amount of a dark brown oil with the distinctive odour of new bread.

The Occurrence of Copper in Olive Oil.

Signor Passerini has analysed 28 specimens of olive oil of different origin and finds that copper is present as a normal constituent, though only in the small proportion of about 0.005 parts in 1,000. Some of the olive trees had been treated with a one per cent. solution of copper sulphate, but this had not increased the quantity of copper in the oil expressed from the fruit of those trees. This minute trace of copper in the oil is obviously too insignificant to have importance from a hygienic point of view.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

A Non-Volcanic Crater.

THE crater of Coon Butte, Arizona, is of a remarkable nature, in that it contains no volcanic rock whatever. This appears at first sight to be somewhat paradoxical, but the theory is now generally accepted that the crater was not formed by the extrusion of material from below, but was the result of the impact of an enormous meteorite falling with a tremendous velocity on to this portion of our globe. This is in variation of the theory which was advanced in 1896, by G. W. Gilbert, that the crater, although exhibiting no volcanic rock, is essentially volcanic, having been produced by an explosion of steam generated by some subterranean volcanic intrusion. This particular district in Arizona has long been remarkable for being the source of many thousands of masses of meteoric iron, and whenever meteors come to be spoken of, those of Arizona are always the first to be referred to. These masses weigh from a thousand pounds down to a few ounces. A detailed examination has been taking place, and this has revealed several thousand additional masses, adding about another ton to the ten tons and upwards already found. We can conceive of a gigantic meteorite weighing many scores of tons, travelling for ages as a small planet, and finally dashing earthwards. Then as it neared that part of the earth where was the American Continent, it suddenly exploded, sending fragments all around, and riddling the soil of the Canyon Diablo with thousands of missles, whilst the main mass struck the earth where now is found the Coon Butte. Besides iron, the meteorites have been found to contain large quantities of the magnetic oxide of iron, with nickel, iridium, and platinum. The crater is now being explored, and meteoric masses have been found therein at depths varying from 300 to 500 feet, with a large amount of minutely pulverised silica, and fragments of limestone, whilst volcanic rocks are conspicuous by their absence.

Intrusive Craters in the Moon.

The formation of a crater by intrusion instead of by extrusion is a phenomenon of extraordinary interest, and astronomers might well consider the possibility of the formation of some of the Moon's craters by a similar process. It has always seemed to me that there is a remarkable likeness in the form of lunar craters to the rising walls around a point in a liquid where a body has fallen in from without. The "splash of a drop" may, perhaps, give a clue to their formation, now that the theory of intrusion as the cause of the crater of Coon Butte has come to be so well established.

Pacific Depths.

In 1899 the United States steamer *Nero* was engaged in the survey of a route for the trans-Pacific cable. From a report which has now been issued, we find that several submarine mountain ranges were encountered, one, east of Guam, having peaks rising to a maximum of 689 fathoms below the sea-levels, whilst the valleys descended to depths of more than 5,000 fathoms. Four soundings below the 5,000-fathom line were made in the abyss now known as the "Nero Deep." The deepest, 5,269 fathoms, was about seventy-five miles east-south-east from the island of Guam, and is the deepest sounding ever recorded, being only sixty-six feet less than six statute miles.

Upper Carboniferous Rocks of West Devon.

The winter meetings of the Geological Society of London opened on November 7, with a paper by Mr. E. A. Newell-Arber, on "The Upper Carboniferous Rocks of West Devon and North Cornwall." The author had been at immense trouble to accurately survey the coast-sections south-west of Bideford, and the result was seen in his comprehensive paper. Special attention was given to two lithological types—(1) the Carbonaceous Rocks, which contain inconstant and impersistent beds of the impure, smutty coal, known locally as "culm"; these beds have yielded plant-remains; and (2) Calcareous Rocks, partly of marine and partly of freshwater origin, consisting of well-marked, impersistent bands of impure limestone, and conglomeratic beds of calcareous nodules embedded in shales. One of the limestone-bands, the Mouthmill Limestone, is marine, and contains an abundant fauna; while in others the only fossils are *Calamites suckowi* and *Alethopteris lonchitica*. The calcareous nodules, which are not ferruginous, occur in thin shale-beds, 2 to 3 feet thick; they commonly contain a marine fauna, with goniatites, lamellibranchs, and fish-remains. The conclusion was reached that the rocks belong to the Middle Coal-Measures, and that there is no evidence of Upper Coal-Measures.

Porphyritic Crystals in Granite.

I note in the *Quarry*, some illustrations by J. T. Rodda, of Eastbourne, of a cruciform twin-crystal of felspar in Cornish granite, a remarkably fine specimen, and of a porphyritic crystal of felspar in similar granite, showing zonal inclusions. It is remarked that there is a good deal of this coarsely crystalline granite, with conspicuous felspar crystals, in London buildings; and when polished these granites give an opportunity for very interesting mineralogical studies, not only with regard to twinning, but also with respect to the regular zonal inclusions of other minerals, which have often been built in the felspars, marking successive stages in the growth of the crystal.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Black-Headed Gull.

THE Cumberland County Council have requested Messrs. Thorpe and Hope, of the Carlisle Museum, to prepare a report on the food of the black-headed gull (*Larus* *ridibundus*), with a view to ascertaining if it is harmful to the fishing or farming industries. Accordingly, these gentlemen have issued a circular requesting answers to the following questions: (1) Do you consider the black-headed gull harmful to fishing or farming industries? State reasons. (2) Have you ever examined the gullet and stomach of this gull? If so, what were the contents? (3) What, in your opinion, is the staple food of this gull?

Under the circumstances, this method of obtaining information is about the only possible one, but it is, nevertheless, most unsatisfactory and unreliable. Of the few people who have ever examined the contents of the stomach of this gull, for example, how many took note thereof, and of these, how many were really qualified to analyse these contents accurately? And on this question the whole case for protection, or otherwise, rests.

This dallying with the question of protective or repressive measures in this matter is to be greatly deplored. It is a question for the Board of Agriculture, who should have appointed, long since, an expert, or experts, to study, impartially and exhaustively, the whole matter of the relation of our native birds to the industries. For years past this line of investigation has been prosecuted by a specially appointed Bureau in the United States, and the results they have achieved are of the highest importance and value.

It must not be forgotten that under the conditions existing to-day in this country any given species of bird may well exceed its proper limits; when exhausting its normal food supply, it may be obliged to tap others, and so become a nuisance. But it is not necessary that new supplies should be tapped; it may become no less a nuisance by drawing too largely on its legitimate food, where this brings it into competition with man, as in the case of fish-eating birds, for example. And in such cases it must certainly be kept in check.

But the "opinion" of the majority of the so-called observers of birds is absolutely worthless.

Greater Yellow Shank in Scilly.

At the first meeting of the winter session of the British Ornithologists' Club, an adult specimen of the greater yellow shank (*Totanus melanoleucus*) was exhibited, which had been killed at Tresco, Scilly Islands, on September 16, by Captain Doreen Smith. This makes the first record of this species either in Great Britain or the Continent. The sex of the bird does not appear to have been determined.

Waxwing in Wales.

In the *Field* (November 17), it is recorded that a waxwing was seen on November 7, near Bala, in North Wales.

Hoopoe at Whitby.

On November 13, Messrs. Rowland, Ward and Co., of Piccadilly, received for preservation a male hoopoe, which had been shot on the moors near Whitby.

Little Owl in Hertford and Elsewhere.

Messrs. Rowland, Ward have also received a little owl, a female, shot at Bramfield, near Hertford, on October 26, and another, a male, shot near Newport, Essex. Another is recorded (*Field*, November 17) to have been seen in Derbyshire on November 5. Since imported examples of this species have been repeatedly set at liberty in this country, it becomes doubtful whether the birds here referred to are genuine wild birds or the progeny of the liberated captives.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Haidinger's Interference Rings.

IN the *Philosophical Magazine* for November, Lord Rayleigh points out that Haidinger was fully acquainted with the character of his rings and especially the distinction between them and the rings named after Newton and dependent upon a variable thickness in the thin plate. The latter are of the same kind as the colours on a soap film, the variety of colour being due to a corresponding variety in the thickness of the film; the colours appear as though painted on the film. Haidinger's, on the other hand, are obtained with a perfectly parallel faced film, such as a thin sheet of mica or selenite, and are due to the different obliquities of the bundles of interfering rays. Contrary to the case of Newton's fringes, they are localised at infinity. The usual text-book formula for the retardation between the interfering rays is:

$$\text{Retardation} = 2\,\mu\,e\cos r,$$

where μ is the refractive index of the film, e is its thickness, and r the angle the ray in the film makes with the normal. The retardation, and, therefore, the particular colour effect, varies with e, and this represents Newton's case. It also varies with r when e is constant, and this is Haidinger's case. Of course, all manners of intermediate effects are obtained when e and r both vary. Lord Rayleigh gives the following directions for best seeing Haidinger's rings by transmission:—"The transmitted rings are best seen by holding the mica close to the eye (focussed for infinity), and immediately in front of a piece of finely-ground glass behind which is placed a salted Bunsen flame." Plates about a fifth of a millimetre thick are suitable. We may point out that a very effective way of seeing them is to replace the ground glass by a lens (a pocket magnifier serves very well), held in front in such a position as to appear "full of light"; the mica, as before, being close to the eye. Those in possession of a mineralogical microscope can obtain the rings very perfectly by placing the mica on the stage and examining the back focus of the objective by means of the additional lens usually supplied for the purpose, which is inserted in the tube; the illumination, as before, must be monochromatic. Lord Rayleigh describes some novel effects. Mica is bi-refringent, and, in consequence, there are two sets of rings. These may nearly annul one another for certain thicknesses of mica. When this is the case, by employing a Nicol prism, which can be rotated, there are four positions for which the inner rings become distinct.

The rings formed on the same mode as Haidinger's are the ones which are employed in Michelson's, and in Fabry and Perot's Interferometers, for the absolute determination of the wave-lengths of light.

Haidinger's Tufts.

The name of Haidinger has also been prominently brought forward in another connection. In the *Proceedings* of the Royal Dublin Society, Professor W. F. Barrett discusses the tufts or brushes which are known by the above name. When a bright sky or any brightly illuminated surface is looked at through a Nicol prism, a pair of small, yellow cones, joined apex to apex, are seen in the direct line of vision. At right angles, and filling the larger space on each side of these cones, a faint blue or violet colour is seen. The yellow tufts resemble an hour-glass. Their longer axis rotates if the Nicol is rotated. If the Nicol is kept unmoved before the eye, the effect vanishes in a few seconds; if the Nicol be now suddenly turned it reappears and again fades. This is the origin of the difficulty which some people experience in seeing the tufts. To ensure their appearance, Professor Barrett recommends that the Nicol be turned backward and forward every few seconds, and a piece of cobalt blue glass be interposed.

When they have been found, they may still be seen even though the Nicol be removed. This is, no doubt, due to the partial polarisation of the light reflected from the white background. These brushes are closely associated with the yellow spot (or *fascicula lutea*), of the eye. That their detection is due to the retina is demonstrated by the following experiment: An opaque screen with two pin-hole apertures, each 1 mm. in diameter and 2 mm. apart, held between the eye and the Nicol prism, would give a double image of Haidinger's tufts if they were due alone to the refracting media of the eye; but only a single image is seen; hence their detection is due to the retina. The size of the region of the retina which is effective can be found by measuring the length of their projected image on a sheet of white paper, placed at a known distance from the eye. Lines drawn from the extremities of this image through the second nodal point of the eye till they meet the retina mark out very nearly, indeed, the retinal area affected. This area is found to sensibly coincide with the area of the yellow spot, whose diameter is from 8 mm. to 1 mm. The *fovea centralis* is only .2 mm. diameter. Hence Brewster and Helmholtz were wrong in attributing this effect to the centre region alone. Throughout the yellow spot the retinal rods are absent, only cones being present; and it would seem as if a close connection existed between this peculiar retinal structure and the detection of polarised light and the plane of polarisation by the unaided eye.

Haidinger, a mineralogist, geologist, and physicist of considerable note, was born at Vienna in 1795, and died in 1871. In 1822 he took up his abode for a time in Edinburgh, after which he returned to Vienna. On the completion of the Geological Survey of the Austrian Dominions in 1862, he superintended the preparation of the maps which were issued.

Alpha Particles.

Professor Rutherford has completed an investigation along with Dr. O. Hahn which shows that, from whatever radio-active source alpha particles are obtained, their properties are identical. This statement applies not only to the particles from the various products of radium, but also to those from actinium and thorium. The observed value of the charge per unit mass comes out about 5,000. The corresponding value for hydrogen as measured in electrolysis is nearly 10,000. The hydrogen ion is supposed to be the hydrogen atom with a positive charge; so that (taking the mass of an atom of hydrogen as unity) the above number, 10,000, represents the positive charge on an atom of hydrogen. If the charge on an alpha particle is taken as being the same as that on an atom of hydrogen the mass of an alpha particle must be about 2. Now, there is very plausible evidence that the alpha particles either consist of, or are easily transformed into, helium atoms. But the mass of a helium atom on the same scale is 4. If the belief in the practical identity of the helium atom and alpha particle is adhered to it is necessary to suppose that the latter carries *twice* the positive charge on a hydrogen atom; or, in other words, carries the same charge as that on any divalent atoms, such as the copper in cupric salts.

Erratum.—In the Physical Notes for October, the focal length of a combination of two lenses should have been given as f_1f_2/K instead of f^2_1/K.

ZOOLOGICAL.

By R. Lydekker.

The Internal Ear of Mammals.

The method of preparing the membranous labyrinth of the internal ear of mammals invented by Dr. Albert Gray has resulted in some important observations on the structure of this region in various mammals, which are recorded in a recent issue of the *Proceedings* of the Royal Society. From an examination of sixteen species, Dr. Gray has been enabled to state that there are differences in the form of the cochlea, in the size of the perilymphatic space of the semi-circular canals, and in the relative size of the otoliths. Apart from its altogether peculiar modification in the egg-laying group, the cochlea presents two main types; namely, a sharply pointed one, characteristic of carnivores and rodents, and a flattened one found in man, monkeys, lemurs, ungulates, and cetaceans. The seal is, however, an exception in this respect among the carnivora, the cochlea being boat-shaped rather than pointed; and among the ungulates the flattened form is least developed in the pig.

As regards the perilymphatic space of the semi-circular canals, this is relatively large in man, monkeys, and the seal, but in the other species examined it is either minute or wanting. Hitherto the otoliths have been assumed to be very small in all cases, but those of the porpoise, [illegible], and the kangaroo have already been proved to be exceptions to the rule.

Popular Science Teaching.

In the *Museum Gazette* for October, occurs the following sentence:—"The ichthyosaurus was a four-footed reptile which had taken to the water and received modifications (loss of feet, etc.), just as the whale is a four-footed mammal which has taken to the water and lost its legs." Later on we read that: "In the manatee and dugong, all the digits are webbed together into a fin, but upon this fin rudimentary nails are produced. In explanation of this we must remember that the nails are modified parts of the skin, and are not formed in connection with the bones."

Should the writer of these passages read them again, we wonder whether he would feel wholly satisfied with the manner in which he has expressed himself. Again, we wonder whether, on reflection, he really believes another statement in the same issue to the effect that the tenrec of Madagascar and the European hedgehog inherit their propensity to slumber from a common ancestor.

New Antelopes.

Africa still continues to yield something new in the way of animals; this time in the shape of a couple of antelopes of more than ordinary interest, which have recently been described in the columns of the *Field*. The first of these is an eland, from British East Africa, of which the mounted head and the body-skin have been presented to the British Museum by Colonel Patterson, its discoverer. The presence of a white chevron on the forehead and certain other details of colouring distinguish this eland (*Taurotragus oryx pattersonianus*) from its kindred further south. Not much in this, the reader may say. As a matter of fact, it is of great importance (so far as it is justifiable to use that term in connection with natural history), since a similar chevron is found in the elands of the Bahr-el-Ghazal and Senegambia, which have been regarded as specifically distinct from the southern animals. Colonel Patterson's specimens suggest that all will prove to be local phases of a single species.

The second new species, based upon a mounted head, shot by Captain P. E. Vaughan, in the south-western district of the Bahr-el-Ghazal province of the Sudan, and presented by him to the British Museum, is a near relative of that handsome member of the waterbuck group from the White Nile and the Sobat known as the white-eared kob (*Cobus leucotis*). The old bucks of the latter are characterised by the ears and much of the jaw, as well as the chin, the throat, and under-parts being white, while the rest of the upper surface is deep blackish-brown. In the new species the general plan of colouring in the adult bucks is nearly similar; but the coloured area is foxy red in place of dark brown. *Cobus vaughani*, as the new species is called, is therefore a connecting link between the white-eared kob and the nearly uniform chestnut species found in Uganda and West Africa.

Crocodile Leather.

A correspondent in the trade, who is a reader of "Knowledge," has sent me two specimens of commercial crocodile leather, with the request that I would give a note upon them in this column. The one specimen is from Mexico, and the other from Florida. In the former, the place occupied by each scale is occupied by a small pore, situated near one end; while in the other such pores are either entirely wanting or are represented by mere traces in some of the spaces. My informant states that these characters are quite constant in Mexican and Florida skins respectively. Mr. G. A. Boulenger, of the British Museum, tells me that both specimens are from the leg, and that while the Mexican example is taken from the American crocodile (*Crocodilus americanus*), the Florida specimen is the product of the Mississippi alligator (*Alligator mississippiensis*). I am further informed that the pores are connected with sensory organs. Why they should be fully developed in the one species and practically obsolete in the other, remains to be explained.

REVIEWS OF BOOKS.

ASTRONOMY.

Stonehenge and other British Stone Monuments. Astronomically Considered. by Sir Norman Lockyer (Macmillan and Co., 1906, pp. xii. + 340; 10s. net).—Readers of Lockyer's "Dawn of Astronomy," in which an almost fabulous antiquity is claimed for certain Egyptian temples, will not be surprised at his having turned his attention nearer home to a similar investigation as to the possible dates of Stonehenge, the Hurlers, the Merry Maidens, and other prehistoric British monuments. Much of the material in the present volume will be familiar to readers of *Nature*, and some of the results have been published in the Proceedings of the Royal Society, but the new volume is a complete discussion of the subject. It is interesting to astronomers to see how many sciences have to own an obligation to astronomy for testing hypotheses, and for many other purposes, very often chronological. In the present instance it is archæology that shares the burden of investigation, but we cannot claim to *know* enough of admittedly prehistoric Britain to be able to do more than acquiesce in the possibility of some of the conclusions. The author's enthusiasm for his subject is apt to carry him to his desired conclusions across a morass of doubtful speculation where "path" is a euphemism for very uncertain stepping stones, on which few would be inclined to venture in search of an *unknown* goal. Once admit the goal and the "stepping stones" are highly ingenious, admirable artifices, but since the question is, after all, a problem and not a theorem, there should be something better than a lack of complete refutation on which to claim success for any solution. Among so many more or less plausible assumptions, possibly more than one, perhaps vital to the argument, might be overthrown, but *cui bono?* Sir Norman Lockyer has in any case produced an interesting book, with admirable descriptions and illustrations, and carefully collected legends on a subject the facts of which, so far as they go, are well worthy of study. Those to whom the "Dawn of Astronomy" brought conviction may accept the results of the present volume without difficulty. Others will be more sceptical, except, perhaps, Cornishmen, or those of Welsh descent, whose pride in the antiquity of their race will enable them to skim the doubtful places, imbued beforehand with the author's faith by their strong sympathy with his conclusions.

BOTANY.

A Text Book of Fungi, including Morphology, Physiology, Pathology, and Classification. by George Massee (London: Duckworth and Co.; 6s.).—This volume supplies a want which has for some time been felt, because of the fact, as stated in the preface, that "During recent years our knowledge of fungi, from morphological, biological, and physiological standpoints respectively, has increased by leaps and bounds," so that this increased knowledge has thrown the existing handbooks out of date, and students were waiting anxiously for a new guide. Inasmuch as a knowledge of the structure and life-history of fungi is now required of those who seek a degree or diploma in Agriculture and Forestry in Universities and Colleges, the issue of the present work is amply justified, and doubtless the right author has been selected for the work, and he gives an assurance that it is arranged as a text book for educational purposes, and is written on the lines required by the Board of Agriculture. Opening the volume, we are at once struck with the number of illustrations (140), which assist in elucidating the text. And again, by the useful bibliography which concludes each chapter, and indicates where further information can be obtained. After intimating that already no less, than 55,000 species of fungi have been described, good, bad, or indifferent, and included in *Saccardo's Sylloge*, with the intimation that probably not more than half of these are autonomic species, it is evident that a text-book of little more than 400 pages cannot by any means exhaust the subject; indeed, it is marvellous how much our author has contrived to condense within that compass, and yet include all the most prominent of the theories and demonstrations of recent times. Nearly half the book is occupied with the classification, which is possibly the least interesting, but not the least essential, although, naturally, the classification of 50,000 plants cannot be fully justified and elucidated within some 200 pages. All mycologists must welcome this volume, which, even the practised hand will find extremely useful, in keeping him up to date. It is, moreover, neatly "got up," of a handy size, and provided with a good index. We heartily commend Mr. Massee's latest literary effort, and can only hope that it will secure the success it so eminently deserves. M. C. C.

The Romance of Plant Life, by G. F. Scott Elliot, M.A. Seeley and Co.; 5s.).—The title to some extent disarms criticism, and we remain in uncertainty as to whether the romancing is done by the author or the plants he mentions. The information offered bears on all kinds and conditions of plants that exist at the present day, or ever did exist, described under such headings as "The Scythian Lamb," "Paleolithic Family," The Caustic Creeper," Ingenuity of Weeds," etc. The story relating to the evil-doings of the famous Upas tree is ruthlessly exposed and stated to be pure romance. Again, the celebrated Traveller's tree, which for all time has been credited with saving the lives of innumerable travellers in the desert, proves to be a myth. The tree has a considerable amount of water in a hollow at the base of its leaf, and it is possible to drink this water. Unfortunately, the tree only grows in the vicinity of swamps or springs, and the water, which the author tasted, out of curiosity, "had an unpleasant vegetable taste, with reminiscences of bygone animal life." Probably the book under consideration is altogether unique in the amount of accurate information, bearing on every phase of plant life as seen in a state of nature, as also on the influence exercised by plants on other forms of life. There are numerous very beautiful whole-page illustrations, and the binding also is quite artistic.

CHEMISTRY.

The Chemistry and Physics of Dyeing, by W. P. Dreaper, F.I.C. (London: J. and A. Churchill; pp. xii. and 315; 10s. 6d. net).—The tendency of chemistry is to become more and more specialised, especially as regards its technical applications, but, on the other hand, the general principles of chemistry and physics underlying various technical processes are gradually being made clear, with the result that on every hand rational methods are slowly taking the place of the time-honoured ones, based on "rule of thumb." In his preface, the author points out that dyeing has lagged behind many other industries in this respect, and that even in the special treatises on the subject the description of working details is given the first place, and relatively little attention paid to the theoretical side; and he has written this book to supply the want. The work opens with an interesting introduction on the history of dyeing, which is followed by chapters on the properties of fibres, the nature of dyes, lakes, and mordants, and their action, evidences of physical and chemical action in dyeing, the part played by colloids in the processes and the action of light on the various operations, and the book concludes with a chapter on the methods of research and good indexes. In each section concise abstracts (with references) of the work done by others in the same field are given, so that the reader gains a complete survey of the whole ground. The book is excellently printed, and the author and publishers may be congratulated on the production of a work that will be most valuable to all interested in the industry of dyeing.

A Practical Chemistry Note-Book, by S. E. Brown, M.A. (Cantab.), B.A., B.Sc. (Lond.) (London: Methuen and Co.; pp. 56; 1s. 6d. net).—This note-book was originally designed for the use of candidates preparing for the qualifying examination of the Civil Service, but Mr. Brown is fully justified in concluding that it will also be found useful as an introduction to practical chemistry. Unlike many of the so-called "note-books," which are compiled solely for examination purposes, it does not do the thinking for the student; but while giving sufficient directions for the progressive exercises, it leaves spaces for descriptions of the experiments and for diagrams of the apparatus to be drawn to scale. It is intended to supplement, but not to replace the demonstration of the teacher, and we can cordially recommend it as admirably adapted for this purpose.

MATHEMATICS.

Five-Figure Mathematical Tables, for School and Laboratory Purposes, by A. Du Pré Denning, M.Sc., etc. (London: Longmans, Green and Co., 1906; price 2s.). This set of tables possesses several original features. The author notices that the mean differences become unwieldy in tables of logarithms of small numbers (*i.e.*, numbers near unity), and also in tables of antilogarithms of large numbers. His way out of the difficulty is to give antilogarithm tables for numbers up to 4 or logarithms up to .61, and logarithm tables for numbers above 4. The plan certainly saves two pages, which would be required if antilogarithms and logarithms of all numbers were given, and these two pages are devoted to antilogarithms and logarithms of reciprocals arranged similarly. The trigonometrical tables are not as clearly arranged as they might be, and we notice with regret that the "tabular" logarithms are denoted by Log, instead of by the old conventional L. If reforms of notation are desirable, let reformers turn their attention to the misleading forms, $\sin^{-1}$, $\cos^{-1}$, and $\tan^{-1}$, before they do away with such a non-misleading symbol as a capital L. The book contains physical and chemical tables, and those students who want to solve triangles without properly learning their trigonometry will find the tables of squares and cubes greatly to their liking.

METEOROLGY.

Falmouth Observatory Meteorological and Magnetical Tables and Reports for the year 1905.—This Observatory is maintained by the Royal Cornwall Polytechnic Society, and is under the supervision of a committee of which Mr. Wilson Lloyd Fox is secretary. Mr. Edward Kitto is the superintendent of the Observatory. The Meteorological Office allows an annual grant of £250 for the carrying on of the meteorological records, and the Royal Society makes a grant of £53 and the British Association a grant of £50 towards the maintenance of the magnetic records. The present report not only gives the results of the meteorological observations for the year 1905, but also the averages for the 35 years, 1871-1905. The averages of the principal elements are as follows:—

Months.		Temperature. Mean. °	Temperature. Daily Range. °	Rainfall. Amount. ins.	Rainfall. No. of Rainy Days.	Sunshine. Amount hours.	Sunshine. No. of Sunless Days.
January	...	43.4	6.8	4.76	20	57.1	12
February	...	43.3	6.9	3.76	17	82.8	7
March	...	43.8	8.4	3.31	18	137.7	5
April	...	47.4	9.1	2.84	15	180.2	3
May	...	51.8	10.4	2.21	13	236.4	2
June	...	57.3	10.6	2.42	14	228.8	2
July	...	60.2	10.6	3.12	16	226.1	1
August	...	59.9	10.0	3.48	16	213.9	1
September	...	56.8	8.9	3.69	17	160.2	3
October	...	51.3	8.1	5.15	20	116.6	5
November	...	47.4	7.2	5.27	19	73.8	8
December	...	44.6	6.6	5.74	21	55.4	12
Year	...	50.6	8.6	45.75	206	1769.0	61

The mean magnetic declination for the year 1905 was 18° 8'.4 W. Falmouth Observatory is in latitude 50° 9' 0" N, and longitude 5° 4' 35" W.

NATURE STUDY.

We have received a copy of "Blackie's Nature-Knowledge Diary," compiled, with introductory notes on nature-study, by Mr. W. P. Westell, and sold at 6d. net. Careful record of all observations, no matter how trivial they may appear, is the point specially emphasised in the notes. The publishers, Messrs. Blackie and Son, Limited, offer prizes to school-children for the best-filled copies of the diary.

PHOTOGRAPHY.

Photographic Lenses; A Simple Treatise, by Conrad Beck and Herbert Andrews. 6th edition, revised (London: R. and J. Beck, Ltd., and Percy Lund, Humphries and Co., Ltd.; price 1s. net.).—The fact that fifteen thousand copies of this book have been called for shows it has met with practical appreciation, and we think that it merits the patronage it is receiving. The title is perhaps rather too broad, for one might imagine from the constant and exclusive references to lenses made by Messrs. R. and J. Beck, that this firm were the only makers of photographic lenses. But as Messrs. Beck make lenses of most of the ordinary types, including the most modern, the reference to their own instruments only does not notably limit the scope of the volume. The authors aim at providing a practical guide for practical photographers who do not wish to dip deeply into the subject of photographic optics. No one of ordinary intelligence can read the volume without getting a very good idea as to what lenses are, how they should be used, and what may generally be expected of them. The numerous illustrations show at a glance the effects described, and the kind of result that may be obtained under certain conditions. We are glad to see that spherical aberration is given as one of the elements that affects depth of definition, but we think that the authors might have departed from the too common custom of considering depth of definition in the centre of the field only. This is not a "practical" method of dealing with the subject. Another suggestion may perhaps be made, that, with regard to curvature of field, the character of the object might be defined, for it is not often enough realized that the image produced is generally, as it were, a solid image, neither curved nor flat, and bears no very simple relationship to what is properly called the field of the lens.

MISCELLANEOUS.

Natural Phenomena; A Collection of Descriptive and Speculative Essays on Some of the By-Paths of Nature, by F. A. Black (Gall and Inglis). This collection of ideas on some of the mysteries still unfathomed by man, includes chapters dealing with the variations of temperature, the peculiarities of the North Pole, the apparent enlargement of heavenly bodies near the horizon, weather cycles, the Sargasso Sea, the Zodiacal light, wind, varieties of Solar days, the rotation of the earth, and the diurnal variations of the barometer. Each of these subjects is clearly described, and its uncertainties discussed, while a number of diagrams, maps, and illustrations add to the lucidity of the descriptions. The frontispiece, a fanciful representation of the Zodiacal light, is the weakest feature of the book.

The Science of Dry Fly Fishing, by F. G. Shaw (London: Bradbury, Agnew, and Co., Ltd., 1906; pp. xii. + 142; price 3s. 6d. net).—The observant angler has such abundant means of studying natural history, either as an essential part of his sport, or for its own sake, that we are quite glad to have the opportunity of noticing the work before us among books of a more strictly scientific nature. The author, whose name has previously been before the public on more than one occasion as a writer, appears to be a most accomplished fisherman, having gained the amateur championship in a recent fly-casting tournament. Whatever he states on the subject may, therefore, we presume, be accepted as thoroughly trustworthy, so that the book may be confidently recommended to lovers of the gentle art. An attractive coloured plate of a basket of trout from the Itchen forms the frontispiece to this exhaustive work.

MESSRS. HENRY SOTHERAN & CO. are publishing, under the title of "Bibliotheca Chemico-Mathematica," a valuable catalogue of works, chiefly rare or historical, on mathematics and astronomy, physics, aëronautics, chemistry, and other scientific subjects. The catalogue is being issued in parts, and in its complete form it should be of great use to librarians or scientific men who wish to complete or fill up libraries. Among other works of special interest, we note the extremely rare first edition of the "De Revolutionibus," of Copernicus, which itself marked a "revolution" in thought; the first printed edition of "Euclid"; the first work on "Ballooning" (Faujas de St. Fond "Experiences de la Machine Aérostatique de MM. de Montgolfier"); and the first edition of "De Caux's "Raisons des Forces Mouvantes," which, according to Arago, contained the germ of the Steam Engine.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Limits of Resolving Power.

It is an accepted fact that there is a theoretical limit to the resolving power of all microscope objectives, this limit being strictly proportional to the numerical aperture of the objective, the numerical aperture itself being a method of notation which takes into consideration not only the angular aperture of an objective, but also the medium with which it is designed to be used, generally air, water, or oil, thus bringing dry and immersion lenses into one common and universal system of notation. It is on account of this theoretical limit of resolution that mere magnifying power, as such, offers us no real advantage, as we are unable to increase the amount of detail shown unless we can increase the aperture of our objectives. It is advisable to call attention to this limit of resolution, because there is some misunderstanding as to the advantages to be gained by increased magnification, more especially with regard to improvements in the image when highly magnified. To put it in another way, we may say that the power of a lens to show detail depends on its aperture, and on the refractive index of the medium with which it is used. This resolving power may be modified, however, to a certain extent by the wave-length of the light used, by the refractive index of the mounting medium, and even in certain cases by the obliquity of the cone of illumination, but the aperture of the lens and its medium are the two important factors. Given such resolution, we must have a certain magnification before we can see what the lens can show us, and an immersion lens of 1.4 N.A. (which is our present practical limit for ordinary work) requires quite a moderate magnification to show us all that it is capable of showing. Therefore, we hear nothing now of lenses like the 1/40" and 1/50" of former days, and high eye-piecing is likewise unnecessary. High eye-piecing has the further drawback of giving us, for various technical reasons, an increasingly imperfect image, and though ingenious methods have been devised to improve such a highly magnified image, it really shows us no more than is shown by the more moderate magnification, and does not, unfortunately, open out to us the new worlds of microscopic vision which some uninformed readers of the microscopic literature of the day seem to anticipate.

With regard to this theoretical limit, however, a paper by Mr. E. M. Nelson, in a recent issue of the Journal of the Royal Microscopical Society, though for the most part technical, contains suggestions which are of interest to workers with the microscope who are engaged in research of various kinds. In the first place Mr. Nelson reminds us that the actual theoretical limit of resolution is not fully determined, the physical nature of the image at the focal point not being yet fully understood, and, consequently, the mathematical deductions not agreeing with the practical results. It follows that estimates of measurement of structure based upon hitherto accepted mathematical tables require modification. Of course, this does not mean that we can see more than we are at present seeing, but that we may be to some extent in error as to our measurements of what we see, when based upon existing tables. Such tables are published by the Royal Microscopical Society, and reproduced in certain text-books on the microscope, and they may require modifying accordingly. But Mr. Nelson's second practical suggestion is that these tables are based on the assumption that the worker uses a nearly full cone of illumination, which few workers do, as few lenses will stand such a cone, whilst, perhaps, fewer workers know how to obtain and utilise it, and, in fact, with the uncorrected Abbe condenser so commonly used it would be impossible. Mr. Nelson gives the specific instance of a biologist who has discovered some minute structure, and announces it as having been made with a 1/12" oil-immersion lens of 1.3 N.A., comp. ocular 12, × 1,500, and Gifford screen. A reference to the published tables would lead one to suppose that the capacity of resolution of this new discoverer's apparatus was 135,800 lines to the inch, and that the structure is smaller than it really is, because he has omitted to inform us that his condenser either would not give a full cone, or was stopped down say to a ¾-cone, with a consequent limit to 1 N.A., and a limit of resolution of 70,000 lines to an inch. Mr. Nelson proposes to obviate all this by the suggestion that the observer should, without disturbing either his illumination or any of his adjustments, place a Grayson's band-plate on his stage, and see which band was resolved, so that in the above case he would add to his published data the words "Grayson band, 60,000," and so do away with all ambiguity, and make it apparent that either a small cone of illumination was employed, or that his objective, apparatus, or eyesight must have been defective.

Royal Microscopical Society.

October 17.—An old portable microscope made by Dollond, presented to the Society by Major F. R. Winn Sampson, was exhibited. This microscope, like others of the same period, was a modification of Cuff's "Newly-Constructed Double Microscope." Instead of a box-foot it was hinged on a bracket in the bottom of the case, which latter thus formed the base of the instrument and admitted of either a horizontal or upright position. One end of the case is hinged so as to let down and allow the mirror to project when the microscope is in a raised position, the instrument lying flat when the case is closed. The stage is focussed by a rack and pinion instead of the body. The eye-lens of the ocular is compound, and consists of two lenses, the one next the eye being plano-convex, and the other double convex. The instrument is the only example of its type in the Society's collection. It resembles a larger microscope which belonged to Sir David Brewster, and which is now in the British Museum. A small pocket microscope, presented by an anonymous donor, was also exhibited. It is a brass box about 1⅞" high and 1⅛ in its greatest diameter. It contains a simple microscope for viewing small insects impaled on a steel point, and two other magnifiers, and a diminutive line box. These magnifiers were not uncommon 30 or 40 years ago, and were frequently made of ivory, and were probably the precursors of the modern pocket lens. An immersion spot lens by Reichert was exhibited, suitable for high powers and for showing ultra-microscopic particles. Messrs. W. Watson and Sons exhibited a new metallurgical microscope, and the new Cathcart Darlaston microtome, as described in "KNOWLEDGE" for November, page 597. A paper by Mr. James Murray on "Some Rotifera from the Sikkim Himalaya" was read in the absence of the author, and was illustrated by large-scale drawings and mounted specimens. Mr. J. M. Coon read a paper on *Connuvia sepula*, illustrated by lantern slides and mounted specimens. Mr. A. E. Conrady gave a summary of his paper on an early criticism of the Abbe theory made by Dr. Altmann in 1880. Dr. Altmann endeavoured to extend the Helmholtz theory by maintaining that the image should be considered as built up of diffusion discs such as Helmholtz had dealt with in his paper of 1873. This paper brought a vigorous reply from Prof. Abbe, in which he added very considerably to the previously published account of his theory, and he laid stress on the difference between a self-luminous object and one illuminated artificially.

Quekett Microscopical Club.

October 19.—Mr. C. F. Rousselet, F.R.M.S., gave a corrected description and exhibited a specimen of the rare rotifer *Tetramastix opoliensis*. Mr. Jas. Burton read a paper, "On the Reproduction of Mosses and Ferns." The position in the vegetable kingdom of these two groups and of their near allies was pointed out. The various methods of reproduction met with among plants were described, and attention was directed to the fact that in the mosses and ferns *both* the non-sexual and sexual methods were developed to the utmost extent in one life-cycle, which cycle is spoken of as a whole as "An Alternation of Generations." Details of the methods of reproduction obtaining in the two groups under notice were given at length, and the differences pointed out. The capsule of the moss was shown to be the counterpart of the fern-plant, while the prothallus corresponded with the evident leafy stem of the moss. The structure of the various organs, etc., involved was described. In these two groups the two methods of reproduction are balanced, neither is developed at the expense of the other, and the ferns and mosses were cited as guides to the processes that occur in the other divisions of organic nature.

Cytology of Bacteria.

The Journal of the Royal Microscopical Society gives a summary of some investigations by A. Guilliermond, into the structure of *Bacillus radicosus*, which is well suited for the purpose by reason of its large size, and which have been recently published in *Comptes Rendus*. In a less than ten-hours-old culture, after fixation in Zenker's fluid, and staining with iron-hæmatoxylin, almost every cell shows a large, deeply-stained central granule, which represents the first appearance of the site of transverse fission, and is formed by the union of two small lateral granules apparently derived from a concentration of the cytoplasm; this large granule, or bi-concave disc, divides into two coloured bands, through which the division of the two cells is effected. After 10 to 12 hours the cytoplasm becomes vacuolated and filled with fine stained granules of varying size, and later shows an alveolar structure filled with fine granules resembling granules of chromatin. The spore appears at one of the poles as a small, deeply-stained granule; it enlarges, takes an oval form, and becomes surrounded by a thick membrane which prevents the penetration of stains. The spore appears to be derived in part from a condensation of the granules of the cytoplasm.

The author concludes that a true nucleus does not exist in a bacterium, and that such as have been described by various authors are misrepresentations, but agrees with Schaudinn that bacteria contain a chromatin more or less mixed with the cytoplasm, differentiated at times and constituting the greater part of the spore.

Demonstrating Life History of Leucocytes.

A recent issue of the Royal Society's *Proceedings* contains a method devised by C. E. Walker, for demonstrating the life-history of leucocytes. He fixes the material with Flemming's fluid (strong formula), Hermann's fluid, acetic acid and absolute alcohol, corrosive sublimate and acetic acid, and strong formic acid. The author remarks that great care must be taken with the processes of fixation, dehydration, imbedding, staining, etc. Extremely small pieces of tissue should be placed in the fixative within about a minute of the death of the animal or removal from the living body. Dehydration should be carried out in short stages, an increase of 10 per cent. of alcohol being perhaps best. This does not apply to tissues fixed in acetic acid and alcohol, or strong formic acid (40 per cent.), from which the tissues are transferred immediately to absolute alcohol. At the same time, it is necessary that the tissues should not be left in alcohol (under 80 per cent.) for more than two or three hours after fixation. In imbedding, no higher temperature than 45° C. should be used. Throughout the processes of staining and mounting, the greatest care must be taken that the sections do not become even partially dried upon the slides. The author states that it is necessary to use a 10-inch tube microscope, with monochromatic light and apochromatic objective and eye-piece, in order to obtain the best definition with immersion lenses, and 27 or even 40 compensation oculars, but he adds that anything approaching this is impossible with the ordinary short-tube—a somewhat incomprehensible statement.

Microscopical Slides.

Messrs. Clarke and Page, of Leadenhall Street, have sent me their new list of microscopical slides, microscopes, objectives, and accessories. I have before called attention to these slides, which are similar to those mounted and sold by Mr. Hornell, and many of them are of great beauty, and moderate in price. Amongst the slides are some prepared and mounted without pressure, including slides illustrative of marine zoology, such as *Bugula turbinata*, and Annelidae, mounted fully expanded, triple-stained palates of molluscs, mounted for polariscope, and a particularly fine slide of the head of a blow-fly, also mounted without pressure, and showing the structure of the proboscis in a way very different to its ordinary appearance when mounted.

Studies in Micropetrography.

Mr. E. Howard Adye is issuing a series of studies in micropetrography, dealing with some 48 different specimens, somewhat on the lines of his recent "Atlas," each section being fully described, with bibliographical references, and with a large coloured illustrative plate, with key. In addition, actual chips of the rocks described can be obtained for comparison and examination. Further particulars can be obtained from the publisher, Mr. Robert Sutton, 43, The Exchange, Southwark, S.E.

[*Communications and enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

The Face of the Sky for December.

By W. SHACKLETON, F R.A.S

THE SUN.—On the 1st the Sun rises at 7.45 and sets at 3.53; on the 31st he rises at 8.9 and sets at 3.58. The equation of time on the 25th is only 7 seconds, and for ordinary purposes is negligible.

Winter commences on the 22nd, when the Sun enters the sign of Capricorn at 6 p.m. Sun spots have lately been comparatively scarce; at the time of writing two small groups are visible on the solar disc.

The positions of the Sun's axis and of the centre of the disc are given below:—

Date.	Axis inclined from N. point.	Centre of disc N. or S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Dec. 2 ..	15° 50′E	0° 35′N	173° 10′
„ 12 ..	11° 42′E	0° 42′S	41° 24′
„ 22 ..	7° 5′E	1° 57′S	269° 40′
Jan. 1 ..	2° 14′E	3° 10′S	137° 57′

THE MOON:—

Date.	Phases.	H. M.
Dec. 9 ..	☾ Last Quarter	1 45 a.m.
„ 15 ..	● New Moon	6 54 p.m
„ 22 ..	☽ First Quarter	3 4 p.m.
„ 30 ..	○ Full Moon	6 44 p.m.
Dec. 1 ..	Apogee	6 24 p.m.
„ 15 ..	Perigee	2 30 p.m.
„ 28 ..	Apogee	6 36 p.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible at Greenwich before midnight:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time	Angle from N point.	Mean Time.	Angle from N. point.	
			p. m.		p. m.		d. h.
Dec. 2	χ³ Orionis	5·1	5 33	111°	6 19	231°	16 9
„ 3	ζ Geminorum ..	var.	10 36	23°	11 10	328	17 14
„ 19	γ Capricorni ..	3·8	4 40	104°	5 39	215	3 22
					a. m.		
„ 25	μ Ceti	4·4	10 59	55°	12 12	263°	10 4
					p. m.		
„ 28	m Tauri	5·1	9 35	67°	10 57	266	13 3
„ 29	χ² Orionis	5·9	7 47	108	8 51	228	14 1

THE PLANETS.—Mercury (Dec. 1, R.A. $16^h\ 15^m$; Dec. S. 19° 46′; Dec. 31, R.A. $17^h\ 19^m$; Dec. S. 22° 37′) was in conjunction with the Sun on the 30th of last month, and is, therefore out of range during the early part of this month. The planet is at its greatest westerly elongation of 21° 35′ on the 18th, when he is a morning star in Scorpio, rising nearly 2 hours before the Sun.

Venus (Dec. 1, R.A. $16^h\ 17^m$; Dec. S. 22° 26′; Dec. 31, R.A. $16^h\ 2^m$; Dec. S. 16° 20′) is a morning star in Scorpio rising about 6 a.m. near the middle of the month. On the 31st the planet rises at 4.48 a.m., or nearly 3½ hours in advance of the Sun, on this date, the telescope appearance is a very thin crescent, 0·08 of the disc being illuminated.

Mars (Dec. 1, R.A. $13^h\ 16^m$; Dec. S. 6° 47′; Dec. 31, R.A. $14^h\ 26^m$; Dec. S. 13° 21′) is a morning star, in Virgo and Libra. Near the middle of the month the planet rises about 3 a.m.; the apparent diameter of the disc is only 4″·6, which is too small for useful observation with telescopes of moderate power.

Jupiter (Dec. 1, R.A. $6^h\ 41^m$; Dec. N. 22° 58′; Dec. 31, R.A. $6^h\ 24^m$; Dec. N. 23° 14′) is a brilliant object in the evening, looking east; towards the end of the month he is due south at midnight, being in opposition to the Sun on the 28th. The planet is describing a retrograde path in Gemini, about 8° north of the star γ Geminorum.

The planet is very favourably situated for observation before midnight, and forms with his belt-like markings and bright moons a most interesting object even in very small telescopes.

On the evening of the 30th, the moon will appear near the planet.

The equatorial diameter of the planet on the 15th is 47″·5, whilst the polar diameter is 3″·1 smaller.

Saturn (Dec. 1, R.A. $22^h\ 44^m$; Dec. S. 10° 10′; Dec. 31, R.A. $22^h\ 50^m$; Dec. S. 9° 27′), is situated about 2° south of the star τ Aquarii. The planet is due south about sunset, and well placed for observation during the early part of the evening; near the middle of the month he sets about 10.30 p.m. The ring, which can be seen in small telescopes with moderate powers, appears slightly open as we are looking at an angle of 6°, on the northern surface.

On the 5th, the outer major and minor axes of the ring are respectively 39″·9 and 4″·3, whilst the polar diameter of the globe is 15″·8. The Moon will appear in proximity to the planet on the evening of the 20th.

Uranus (Dec. 15, R.A. $18^h\ 34^m$; Dec. S. 23° 32′), is in conjunction with the Sun on the 31st, and hence is unobservable.

Neptune (Dec. 15, R.A. $6^h\ 51^m$; Dec. N. 21° 2′) rises about 5.30 p.m. near the middle of the month, and is due south about 1 a.m. The planet is situated in Gemini, about 1½° N.W. of ζ Geminorum, but in small telescopes without setting circles it is difficult to identify from the numerous small stars in the same field of view, but he can be detected by his motion if observations are made on several successive nights. The planet is in opposition to the Sun on the 31st.

METEORS:—

The principal shower of meteors during the month is the Geminids, Dec. 10th to 12th; the radiant is near Castor, in R.A. $VII^h\ 12^m$, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

VARIABLE STARS:—

Minima of Algol may be observed on the 5th at 11.17 p.m., the 8th at 8.6 p.m., the 11th at 4.55 p.m., the 28th at 9.48 p.m., and the 31st at 6.37 p.m.

ο Ceti (*Mira*) is due at a maximum on the 20th, but observations should be made some weeks on either side of this date as the period is uncertain.

TELESCOPIC OBJECTS:—

Double Stars:—1 Pegasi $21^h\ 17{\cdot}5^m$, N. 19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedæ $0^h\ 31{\cdot}5^m$, N. 33° 11′, mag. 4·0, 8·0; separation 36″·3.

α Piscium $1^h\ 56{\cdot}9^m$, N. 2° 17′, mags. 3·7, 4·7; separation 3″·6.

ι Trianguli $2^h\ 6{\cdot}6^m$, N. 29°50′; mags. 5, 6·4; separation, 3″·5.

Clusters:—(H VI. 33, 34). The Perseus clusters visible to naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."

(M. 34.) A mass of small stars about the 8th magnitude; not very compact. The cluster is just perceptible to the naked eye about 5° N.W. of Algol.

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