Knowledge

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

CONDUCTED BY

Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

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

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To Volume XXXV. New Series Volume IX. (1912).

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JANUARY, 1912.

EDITORIAL.

In answer to the request which has been printed on the cover of "KNOWLEDGE," many of our readers have been so good as to write and point out the particular branches of science in which they are most interested. Judging from the past history of the Magazine, and from the fact that there is no other that deals with Astronomy in quite the same way, it was to be expected that this subject would have the most votaries. Such was found to be the case and we would ask our astronomical readers to make known to their friends, especially those abroad, the fact that Dr. Crommelin is expanding the column entitled "The Face of the Sky," as well as publishing his material two months in advance so that it may reach subscribers in most parts of the world in time to be of service to them.

The success of any undertaking is dependent to a large extent upon the co-operation of every one concerned, and astronomers could help us most materially by giving information to us as to photographs of interest which they would like to see reproduced as plates in the pages of "KNOWLEDGE."

The microscopists came in a very excellent second, and to them it may be said that an endeavour will be made to extend the scope of the microscopical column, and, in the near future, to introduce special articles which will appeal to them. About equal numbers of our readers occupy themselves with chemistry and physics and the natural history sciences, but there is a slight preponderance of botanists over geologists, and of the latter over those who specialise in zoölogy.

With regard to the first two sciences it must be owned that we have some difficulty in obtaining just the sort of articles which are suitable for the pages of "KNOWLEDGE." There is a tendency for them to be too highly specialised, but so much original work is being done in these subjects at the present day that it is not easy for those engaged in it to get their results published promptly. There must be much among their researches that would appeal to the amateur, and we invite chemists and physicists to make suggestions on these matters to us for the mutual advantage of ourselves and our readers.

We thank our numerous correspondents for their kind criticisms and commendations. Several have expressed a desire that "KNOWLEDGE" should be made more like the old *Hardwicke's Science Gossip*, the title of which is incorporated with our own. Knowing, as we do, something of the working of *Science Gossip*, we may say that practically everything which appeared in it was written for love, by the readers themselves, and the times seem somewhat to have changed since then. It has been, however, our endeavour to provide, in accordance with precedent, some articles which will appeal to all those who are interested in the world around them, and the attention which these contributions have aroused has been reflected in the columns of our contemporaries. We should therefore be particularly glad to hear from possible contributors, in this or any of the directions which we have previously indicated.

FIGURE 1. Gem pit showing primitive crane and pool at which the earth is washed for gems.

CEYLON: THE ISLAND OF JEWELS.

By LEOPOLD CLAREMONT.

Author of "The Gem-Cutter's Craft," and "The Identification of Gems."

THE gem-minerals with which Ceylon is so generously endowed are remarkable, not only for their beauty, but also on account of the great variety of them.

Although the diamond, opal, emerald, and peridot are conspicuous by their absence, all the other well-known transparent gems are abundantly represented in the island. There are also many very beautiful precious stones with which the general public, at all events, is more or less unfamiliar.

The principal mineral is corundum, of which the red and blue varieties constitute the gems ruby and sapphire. (See Figure 2.) It, however, also occurs in a long series of different colours of varying shades, which range from the ruby-red to delicate rose pink; from the royal sapphire to sky blue; from plum to violet and lilac; and from golden orange to primrose.

There is also a most attractive rich salmon-pink variety, resembling the tint of the "Sunrise" rose and which is known in Ceylon as *patparagum*; and very rarely only, the mineral is found green in the island.

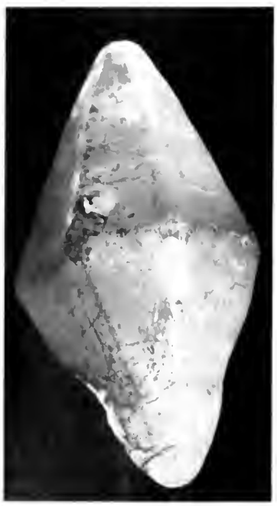


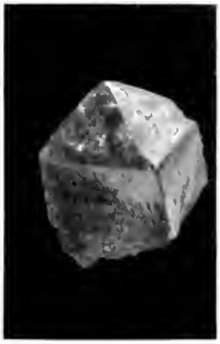
FIGURE 2.
A somewhat water-worn crystal of Sapphire.

In Central Queensland, however, at a place called Anakie, the green variety is fairly plentiful, while the red and purple are entirely absent.

Some of the corundum gem-stones exhibit the phenomenon of *asterism*, that is, they display a bright shimmering six-pointed star with the rays divergent from the centre of the stone when it is cut with a smooth convex surface.

They are found almost exclusively in Ceylon (a few ruby star-stones are found in Burmah), and under the name of *asterias* or *star-stones* are highly valued by connoisseurs when of choice quality. For some unknown reason, the yellow and green varieties of corundum do not exhibit the phenomenon of asterism.

Another gem-mineral which



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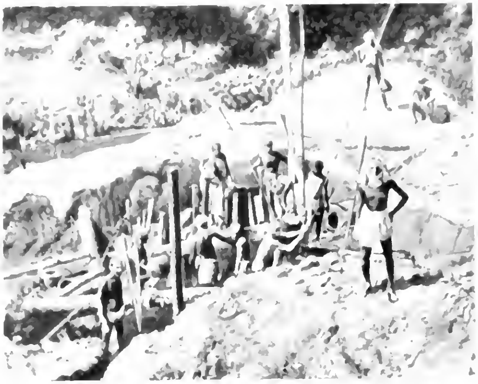


FIGURE 6.

[illegible]

FIGURE 7.

The "gemming" basket [illegible]

possesses a [illegible] extensive range of colour, except the [illegible] possesses, is the spinel. Some specimens of this somewhat resemble rubies and sapphires, and are therefore often described as "spinel rubies," and "spinel sapphires" respectively. It is, however, very much softer than corundum, and is one of the three gem-stones, occurring in the form of crystals, which are singly refractive, the other two being diamond and garnet.

There is a remarkable flame-red variety of spinel, the colour of which is unique in the whole mineral world, not even excepting the ruby. It is an exquisite gem of great value.

The chrysoberyl is an attractive gem stone, although its beauty is somewhat unappreciated. It occurs in shades of Autumn green, brown, and yellow, and possesses great brilliancy. There are, however, two varieties of this gem-mineral which form well-known and valuable precious stones; of these, the most important is known as the *alexandrite*. (See Figure 1.) Fine examples of this gem by daylight appear pistachio-green, changing to rich mulberry-red by artificial light.

Ceylon is the chief source of alexandrites, although a few are found in Siberia.

The other important variety of chrysoberyl is the *cymophane* or cat's-eye, which, when cut with a smooth convex face presents a narrow white line glittering across it, which has a fancied resemblance to the iris of a cat. The position of the line or ray alters as light strikes it from different angles, giving a peculiarly mysterious effect. Cymophanes are only found in Ceylon.

The rarest and most curious of all precious stones are those cat's-eyes which change from green to red, as do the alexandrites.

FIGURE 8.

[illegible]

FIGURE 9.

The lighter stones slip over the edge of the basket.

By the superstitious natives the cymophane is considered to be an entombed spirit, and this can be more readily understood than many other similar conceits, because of the strange resemblance of the stone to the eye of an animal.

Many shades of soft yellow, brown, cinnamon and green are displayed by specimens of the mineral jargoon or zircon. (See Figure 5.) This gem-stone is strangely unappreciated, for not only is the colouring most pleasing, but the brilliance is second only to that of the diamond.

Another reason why the neglect of the zircon is unaccountable is that this beautiful gem is comparatively inexpensive.

The writer has only space briefly to complete the list of precious stones of Ceylon, for his object is to give the reader some idea of the manner in which they are handled.

There are garnets, red, brown, violet and cinnamon; topazes, white and blue; tourmalines, red, claret, green, yellow and blue; aquamarines or beryls, sky-blue and sea-green; besides iolotes and moonstones. (See Figure 5.)

Figure 10.
Native gem cutters at work with the overseer watching them.

From the foregoing paragraphs it should be apparent that these gems present a pageant of colour unequalled by those of any other district.

From the finding of a precious stone in a river-bank or gem-pit, to its use as a jewel by a woman of fashion, it passes through many strange hands, and undergoes much alteration in appearance.

The securing, cutting, polishing and marketing of such a large number of gems necessarily comprise an important industry. The entire trade is controlled locally by the Moormen, many of whom are extremely wealthy.

The foremost of them not only buy up the most important stones as they are found from time to time, but send out expeditions into the principal gem-producing areas to search for them. They all either retain their own cutters or superintend the work given out to be done. No foreigner is admitted within the magic circle of the Moormen except as a customer.

The Moormen are descendants of the Moors who once occupied Ceylon, and of whose forts large ruins still exist in the island.

The value of the precious stones annually exported to Europe and America from Ceylon is estimated at three million pounds, and high prices, especially for choice specimens, are realised locally from travellers and tourists.

The gem-stones are of igneous origin, and have been loosened from the granite and gneissic rocks in which they were formed, by disintegration. They are found in a stratum of alluvial gravel which is known to the natives as "illam," which is reached by digging pits of from three to thirty feet in depth. They are generally in the form of more or less water-worn nodules, undamaged crystals being very rare. (See Figure 2.)

When the pits are deep, the illam is hoisted to the surface by means of a primitive kind of wooden crane (see Figure 1), and it is then carried to the nearest stream or pool to be washed.

It is often found, in low-lying spots, that old disused gem-pits which have become filled with water, are available for the washing of the gem-bearing material.

The illam consists of gravel embedded in yellow or reddish clay, and is usually brought to the surface in a dry condition, but when the gem-pit is below the level of a neighbouring stream, it is rather muddy.

Sometimes the stratum of illam *crops out*, or is exposed upon the surface of the country, and this is generally found to occur on the slopes and banks of rivers and streams. When this is the case, very little excavation is done, as the material is more easily obtainable.

The searching for gems is carried on from October to March. The washing is done by means of a circular basin-shaped basket, about twenty-eight inches in diameter and twelve in depth, which is called a "gemming basket"; the native wading up to his knees holds the basket in the water. (See Figure 7.)

A circular turning movement (see Figure 8) is given to the basket, which is occasionally allowed to tilt below the surface of the water, and in this way the lighter stones slip over the edge, and the heavier ones remain in the basket. (See Figure 9.)

After a good many baskets full of gravel have been washed in this way, the residue, which is found to contain thorianite and thorite and other heavy minerals, is carefully searched for gem-stones.

The number of gems found of insignificant value is extremely large in proportion to that of the choice specimens, so that often a great deal of work is done before there is any prospect of recompense.

When an important stone is discovered there is great excitement among the natives, and many would-be buyers eagerly endeavour to outdo each other in obtaining a bargain. The price asked is [illegible] generally [illegible] as possible.

Many tales are [illegible] [illegible]

Figure 11.
A Moor Lapidary, Ceylon.

purloin from the rightful owner, or to substitute an inferior stone for one of good quality. The diggers and washers are continually watched to prevent anything of the kind from taking place.

It is a matter of great difficulty for Europeans to obtain details or photographs of the gemming industry, for the natives are very jealous and secretive, and object to company upon their expeditions. They are also exceedingly superstitious, and believe in all sorts of devils and evil omens; they will not even allow one of their own women to go near a gem-pit, because she would be sure to bring bad luck to it.

There are several extensive districts in the island where precious stones occur, but the most productive locality is the hilly country of Saffragam, the chief town of which is Ratnapura, or in other words "the city of rubies."

Nearly all the different kinds of gems are found occurring together, the exceptions being moonstones, amethysts, and alexandrites, the last of which are principally derived from Galle.

The natives have a great prejudice against sending gems out of the island in the rough state, and always cut and polish them locally. This [illegible] [illegible] [illegible] [illegible] in value.

The cutting and polishing is done on the small [illegible] perpendicular wheels which are coated with emery, against one side of which the stone is pressed with the left hand, while the wheel is rotated by means of a bow and cord held in the right. See Figures 10 and 11. The whole apparatus is most simple and primitive, the success of the work depending entirely upon the skill of the operator.

The cutters squat upon their haunches behind the wheels, and sometimes an overseer watches the progress of work to prevent theft. (See Figure 10.) Much of the cutting is done by the roadside in view of every passer-by, but many little "tricks of the trade" are withheld from public view.

The native gem-cutters' chief object is to so manipulate the precious stone that the maximum of size and weight is retained, often to the sacrifice of symmetry and brilliancy. They are wonderfully adept at retaining and regulating the colour, which in some gem-stones is not of uniform density throughout, and in dexterously hiding feathers and flaws. Owing, however, to irregularity, and also the want of symmetry and proper proportion, it is

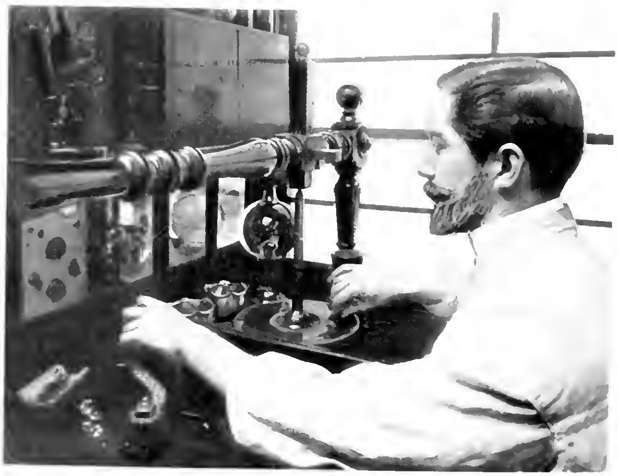


Figure 12.
[illegible] a Ceylon [illegible] in Europe.

generally found that the gem-stones in the "native-cut" condition are unsuitable for the requirements of high class European jewellery. It is therefore necessary, before they can be used for the purpose, that they shall be re-cut by a skilled lapidary with a knowledge of mineralogy and optics.

In principle, the apparatus used by the European gem-cutter is similar to that used by the Moor in Ceylon. The wheel is, however, made of copper and diamond dust, and revolves horizontally instead of perpendicularly (see Figure 12).

The operator sits at a bench and places the stone, mounted on a small ebony holder, against the surface of the wheel which he rotates by means of a crank held in the left hand. Although the apparatus is simple, much expert knowledge, skill and experience are requisite for success in this delicate and artistic craft.

CORRESPONDENCE.

THE NEED FOR TELESCOPES.

To the Editors of "KNOWLEDGE."

SIRS,—It is indeed strange, as Professor Bickerton observes, that Astronomy has not a greater hold on the human mind. But perhaps the general public are not altogether to blame for their neglect of that glorious science. Compare, for instance, the facilities enjoyed by townspeople for literary study, with the opportunities given them to use a good telescope in connection with star maps and text books. Where can the "man in the street" go to feast his eyes on the clusters so eloquently described by Professor Bickerton?

Years ago I was young and naive enough to ask if I might go to Greenwich to look through the Observatory telescope. I can well understand that casual amateurs would interfere with investigations at the great centres of observation. But, surely, reading rooms, libraries and village clubs here and there might be provided in an upper floor with a 12 in. telescope, under the care of some responsible person in the neighbourhood, who would instruct an attendant.

Wanted, then, a scientific Carnegie to provide telescopes.

No doubt that the taste for star-gazing is growing, and that the *Daily Telegraph* reflected general interest in publishing monthly charts of the sky.

Professor Bickerton's shepherds and, I would add, fishermen, would appreciate, even more fully than they do, the beauty of the heavens, when they learnt to identify groups in single stars, and could follow their motions. Their educated friends should pass on some elementary knowledge to simple people by the only sure methods, namely, by pointing out constellations in stars when opportunity offers, and especially drawing attention to their changing positions as time goes on.

L. M. M.

WAREHAM.

METEORS.

To the Editors of "KNOWLEDGE."

SIRS,—Will you allow me a little space in your valuable paper in which to make an earnest appeal to all amateurs who are interested in meteoric observations?

Too little regular work is done in England and, with the successful example of Mr. Denning before us, we in this country who are at all enthusiastic in the matter, might do much work that would be valuable if only we undertook to systematically watch the sky and furnished full reports of our seeings to someone qualified to investigate them.

For many months past my husband and myself have observed every fine evening at regular hours and sent in frequent reports to Mr. Denning with whose results we have had many interesting accordances. Unfortunately as he is not well now and his work limited, many of our observations are of little use, as of course it is only by two observations of the same meteors in different places, that any accurate knowledge can be obtained of their real paths. Will some amateurs who care about this branch of astronomy agree to watch regularly, evening by evening, at stated times, and send us each week or month their records, which we can then compare with ours and write out both together and send to Mr. Denning or some other authority.

If two hours or more are too long the time could be divided, and each observer have perhaps half an hour or so, we could easily manage to arrange in a way suitable to everyone's wishes. It is such interesting work! All day long I look forward to the silent hours when our watch begins, the stars seem no longer far away twinkling lights, but intimate friends, and each moment is filled with the glow of anticipation as to what grand meteor will next appear on the scene.

In our observations we record the times, magnitudes, Right Ascension and Declination, of appearance and disappearance, direction of flight, details of colour, train or trail, and so on. If any of those who, after this appeal, consent to watch, do not care to spend time in determining the Right Ascensions and Declination, or the altitude or azimuth, the name of the star where the meteor appeared to come, and the one where it appeared to go to, will be quite sufficient, if they will kindly mention the name of the star atlas they use, as some of the smaller stars have different letters or numbers in different maps, and it might be difficult to trace them. My address is "Zaymaya," Hansol Road, Bexley Heath.

FIAMMETTA WILSON.

TO FIND APPROXIMATELY SIDEREAL TIME.

To the Editors of "KNOWLEDGE."

SIRS,—May I add a post-script to my letter of November giving the equation R.A. = h + 2 m + 5 as an approximate index to Sidereal time?

As a practical application of the equation I have marked on my watch-dial +0 against IX, +6 against XII, and +12 against III to remind me that on 22nd September Sidereal and clock time are the same, and that in December the difference is six hours, and in March 12 hours.

LYNDHURST. FRED B. TAYLOR.

THUNDERSTORMS.

To the Editors of "KNOWLEDGE."

SIRS,—I have been for a great number of years a very careful observer of Thunder-storms and Electrical Phenomena in this and other countries, and possibly some day I may trouble you with a few of my notes. But I write now to put a question to your readers which is perhaps more amusing than scientific. Inasmuch as the world is round and thunderstorms like everything else have a beginning, it follows that the first flash of lightning in any storm must be directly over somebody's head. How is it then that we cannot meet with anyone who remembers anything of the sort? We are invariably told that distant thunder was heard, or, if by night, distant lightning was seen near the horizon, and the storm gradually approached. *The Times*, in describing a storm in London, always begins in this way: "Heavy clouds were observed in the West and a little later distant thunder was heard, and at such and such a time the storm broke over London." This, too, is the way local newspapers always describe storms. Considering how common in the late spring thunder showers are, it seems strange that wherever we are they always make their first appearance in the distance.

TANKERVILLE CHAMBERLAYNE.

WINCHESTER.

MR. ROBERTSON AND MR. PROCTOR.

To the Editors of "Knowledge."

[illegible] founded [illegible] proper [illegible] the matter in your columns.

[illegible] Letters above referred to, Mr. [illegible] Mr. Proctor's statement that in the [illegible] coin-tossings by Button and others [illegible] (which frequently occurred) was [illegible] by another head as often as it was followed by a tail. He says that, in making this statement, Mr. Proctor was "in effect asserting that in the given experiments runs of thirteen heads were exactly as common as runs of twelve, and if his argument were coherent, he was committed to arguing that runs of fourteen were as common as runs of thirteen, and so on indefinitely." Now, a moment's consideration ought to show that Mr. Proctor was simply asserting, in effect, that runs of thirteen *or more* were as common as runs of twelve; but as Mr. Robertson professes not to see this, I will now make the matter even more simple than I did in my letter to him.

According to Mr. Proctor's statement, it will be seen that if there were *four hundred cases* in which *twelve heads* were followed by a tail, there would also be four hundred in which they were followed by a thirteenth head; and out of the latter four hundred, there would be *two hundred* in which *thirteen heads* were followed by a tail, and two hundred in which they were followed by a fourteenth head; and out of the latter two hundred there would be *one hundred* in which *fourteen heads* were followed by a tail, [illegible] different [illegible] that Mr. Robertson [illegible] that Mr. Proctor [illegible] that result would be a [illegible] and I trust he will now admit that [illegible] proof of Mr. Proctor's "pure absurdity" [illegible] under-fondness of [illegible].

W. T. DUNTON.

[illegible]

THE SUN AND ITS EFFECT ON VITALITY.

To the Editors of "Knowledge."

Sirs,—Perhaps the following may be of interest to some of your readers:—

Not long ago Mr. Tillemont Thomson, lecturing at Liverpool, said he believed that there was no heat at all in the sun, and never has been. He supposes the sun to be the source of, or to have stored up in it, an incalculable amount of some kind of energy, and that part of this is transmitted through the ether and when it meets our atmosphere is transformed and produces what we know as heat.

If such be true, then, as there are various kinds of ether waves just as there are various forms of matter in existence, is it not possible that there comes from the sun some other kinds of unknown ether waves which have a direct effect on our vitality? My reasons for supposing such are that, as every one knows, during the early hours of the morning, when the sun is on the other side of the earth, our vitality is at its lowest, and is the time when most people die; moreover, this is *not* due to the effect of the lowered temperature at that time, it is due to something outside all that, because even if these conditions are counteracted for by artificial means, the vitality is lowered still to a certain extent. We know that electricity has an effect on our bodies and nervous systems, and that ether waves affect material substances, so could there not be some ether waves having effect on our vitality?

C. POTTER.

Birkenhead.

ANNOUNCEMENTS.

CLASSES IN PHOTOGRAPHY.—We are asked to announce that Mr. Edgar Senior's classes in Photography for the winter session, will open at the following Polytechnics on the dates specified: Battersea, Tuesday, January 9th; South Western, Monday, January 15th and Woolwich, Wednesday, January 10th, 1912.

ILLUMINATING ENGINEERING.—On Friday, January 12th, Mr. J. S. Dow, D.Sc., will begin a course of Lectures dealing with the measurement of light; the comparison of day and artificial light; and practical lighting problems; at the Battersea Polytechnic.

PALAEOBOTANY.—On January 16th, 1912, and on the nine following Tuesdays, at 4 p.m., Miss Marie Stopes, Ph.D., D.Sc., will deliver a series of Lectures in University College, London, on "General and Geological aspects of Palaeobotany." The course is intended for students of Geology, Botany and Mining Engineering, and the fee is one guinea.

ROYAL INSTITUTION.—A General Meeting of the Members of the Royal Institution was held on the 4th instant, Sir James Crichton Browne, Treasurer and Vice-President, in the Chair. Miss Goldsmid, Dr. Habibur Rahman Khan, Dr. W. M. Scott, and Mrs. Middleton Robinson were elected Members. Professor W. C. Brøgger (Christiania), Geh. Rath Professor T. Curtius (Berlin), Professor P. A. Guye (Geneva), and Geh. Regierungs Rath Professor H. Rubens (Berlin), were elected Honorary Members of the Royal Institution. The Chairman announced that the Managers at their Meeting held this day, had appointed Mr. W. Bateson, M.D., F.R.S., Fullerian Professor of Physiology for a term of three years. The following are the Lecture Arrangements at the Royal Institution, before Easter:—Dr. P. Chalmers Mitchell, a Christmas Course of Six Illustrated Lectures on The Childhood of Animals, adapted to a Juvenile Auditory: 1. Introductory; 2. The Duration of Youth; 3. Colours and Patterns of Young Animals; 4. Young Animals at Home; 5. The Feeding of Young Animals; 6. The Play of Young Animals. Mr. W. Bateson, Fullerian Professor of Physiology, R.I., Six Lectures on The Study of Genetics. Professor E. G. Coker, Two Lectures on Optical Determination of Stress and Some Applications to Engineering Problems. Dr. T. Rice Holmes, Three Lectures on Ancient Britain. Professor A. W. Bickerton, Two Lectures on the New Astronomy. Professor A. M. Worthington, Two Experimentally Illustrated Lectures on The Phenomena of Splashes. Mr. M. H. Spielmann, Two Lectures on The Portraiture of Shakespeare. Mr. F. A. Dixey, Two Lectures on Dimorphism in Butterflies: 1. Seasonal Dimorphism; 2. Sexual Dimorphism. The Rev. John Roscoe, Two Lectures on The Banyoro: A Pastoral People of Uganda; 1. The Milk Customs; 2. Birth and Death Customs. Sir Alexander C. Mackenzie, Three Lectures on: 1. The Russian Music of To-day, with the kind assistance of the Hans Wessely Quartet; 2 and 3. Franz Liszt (Centenary) (with Musical Illustrations). Professor Sir J. J. Thomson, Professor of Natural Philosophy, R.I., Six Lectures on Molecular Physics. The Friday Evening Meetings will commence on January 19th, when Professor Sir James Dewar will deliver a Discourse on Heat Problems. Succeeding Discourses will probably be given by Professor Bertram Hopkinson, Dr. J. Mackenzie Davidson, Dr. J. A. Harker, Rt. Hon. Sir John H. A. MacDonald, Mr. G. K. B. Elphinstone, Dr. W. J. S. Lockyer, Mr. F. Soddy, Professor D'Arcy W. Thompson, Professor Sir J. J. Thomson, and other gentlemen.

FIGURE 13.

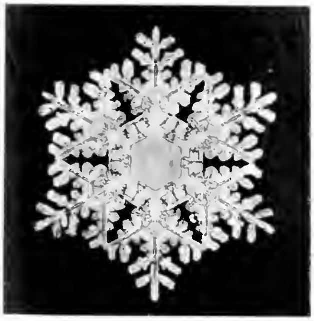


FIGURE 14.

FIGURE 15.

SNOW CRYSTALS.

By WILSON A. BENTLEY.

CRYSTALS constitute a most interesting and important part of Nature. Their manner and habits of growth are marvellous and full of interest. The seeming similarity of some of their forms and way of growing, to certain of the lower organisms, and to certain vegetal forms, their power of increasing in size and of repairing broken parts, and so on, have almost led some to consider them as constituting the first span bridging the vast gulf existing between the inorganic and organic kingdoms.

However this may be, there is certainly a great difference between plants and flowers, and crystals. Plants and all organic life grow from within outward, and have their forms pre-limited, as they reach a certain size and then cease growth.

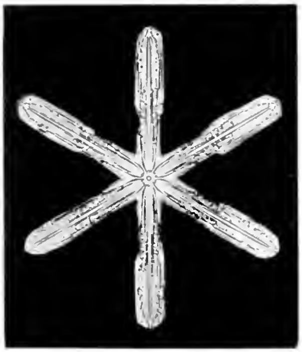


FIGURE 16.

Crystals, on the other hand, grow wholly from without, by deposition, and properly never reach maturity, as they are always in a state of incompleteness, and ever ready to resume growth whenever fresh supplies are furnished to them.

Crystals form within saturated gases and chemical solutions and magmas of various kinds, and are usually so situated and surrounded by material as to have equal chances of growing equally in all except basal directions. But they grow mainly, except possibly during their first or microscopic beginnings, in special directions only, thus furnishing proof that certain parts of a growing crystal attract material to themselves in excess of others, and hence have excessive attractive powers for the molecules of matter of which they are constructed. These points of major attraction, when occurring upon the molecules of matter, are called poles; and when occurring upon crystals, axes.

FIGURE 17.

It is assumed that these attractive poles and axes are essentially tiny fixed charges of electricity, and that their number and arrangement is identical as regards the molecules of a given substance, but varies one substance or mineral with another, and that they determine the form and system to which crystals belong. According to this theory, the molecules of water, of which snow crystals are constructed, possess two major and opposite poles, and six (or three) secondary ones. Water, being a diamagnetic substance, presumably tends to arrange itself at right angles to the two main and opposite poles and axes, and hence deposits itself mainly upon and from the secondary poles and axes. Singularly enough, though they grow largely from these polar or axial parts, there are oft-times moments when certain crystals grow in equal or greater degrees from other and intermediate directions, as though new axial points were established upon them. It is assumed in such cases that tiny additional electric charges collect upon the crystals, outside the main axial points, either directly from the indrawn molecules, or through overflow from an excess of electricity collecting at the main axial points, and actually do momentarily increase the number of attractive polar or axial points upon them.

It is presumed that crystals, forming within a scantily electrified solvent, acquire excess charges at their axial points, or elsewhere, only at rare intervals, or not at all. Under these conditions but few or no new and secondary axial points would be established upon them. The crystals would, under these conditions, grow mainly from their primary axial directions alone, or from such secondary charges as might collect upon them, and hence in an open rayed, or branching form, or in the shape of long slender spiculae. Crystals forming in a highly electrified solvent would likely acquire many additional charges from the indrawn molecules of the solute, and become completely, or more nearly, charged over their whole exteriors, or at least around their edges, rendering all parts more equally attractive. This would likely cause all parts to grow in a more nearly equal degree, and force the crystals to assume more solid close forms.

Figure 18.

Among the more remarkable crystals that occur in nature are those called snow, that form in such vast quantities from the moisture in solution within the gaseous solvent, our atmosphere. Snow must be considered as one of Nature's most wonderful products, viewed in any light; whether for quantity, frequency of occurrence, distribution, place and manner of origin, or for the beauty, complexity, and marvellous symmetry of its crystals. Snow crystals are the only crystals that form (in quantity) from a gaseous solution, *i.e.* from a solute dissolved in a gas (the air).

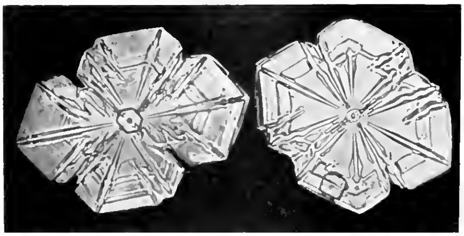


Figure 19.

The tenuity of the solvent, air, within which snow forms, far exceeds that of the other liquid and magmatic solvents, wherein crystals form. This extreme tenuity of the solvent allows the molecules of water a wonderful and unapproached freedom of movement and adjustment among themselves while arranging themselves in crystal form, which perhaps partly explains why they so greatly excel others in beauty and perfect symmetry. Snow and ice crystals are perhaps the only ones that form largely while in motion, *i.e.*, while drifting about within the solvent, and hence, in the case of the snow, that develop under constantly shifting conditions of temperatures, viscosities, and so on. They have a habit of crystallizing largely on thin tabular planes, hardly thicker than paper, thus exposing their whole structure to view under the microscope, as though ground into sections for this especial purpose.

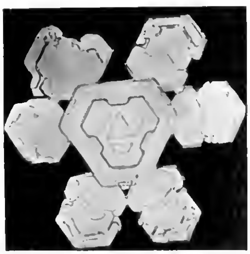


Figure 20.

These facts, coupled with their common occurrence and accessibility as objects for study, gives them an unique place among their fellows, and an unrivalled value as objects for crystallographic research. It may well be that we shall learn more regarding crystals from a study of them and of their next-of-kin, the frost and ice crystals, than through all other sources.

These considerations, and our great love for Nature-study, led us, while yet in our "teens," to begin a most enthusiastic and comprehensive study of these marvellous crystals. This has been continued ever since, for now over a quarter of a century. During this time we have secured many thousands of photo-micrographs of the various forms of water, snow, frost, ice, dew, and so on—two thousand of snow crystals alone, no two alike.

Our location, Jericho, Vermont, U.S.A., fortunately, was very favourable, as it lies in the path pursued by most of the general storms crossing North America.

This doubtless largely explains why the snows of our locality are so very rich in perfect and beautiful snow forms. Winters were found to vary greatly in productivity, some being much more favourable than others.

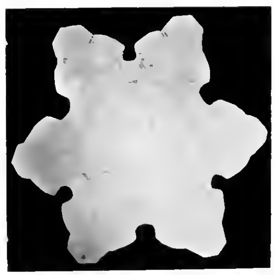


Figure 21.

Some winters furnished very few perfect crystals, but in general we were able to secure and photograph from one hundred to two hundred perfect forms each year to add to our collection. It is probable that favourable winters occur in cycles; but more data, covering a longer period, needs to be collected to make this a certainty. Only one storm in about seven, in our locality, furnished many perfect tabular forms such as we required. It is quite certain, however, that all general storms possess favourable quadrants (the western ones) furnishing perfect tabular forms, their failure to furnish these at any one time or place being due to the fact that their paths fail to bring these productive quadrants over the locality in question.

Figure 22.

The student of the snow finds much to marvel at in a study of these peerless crystals. What perhaps causes the greatest amazement, is their almost infinite diversity of form and interior. Yet one is almost equally impressed with the almost unbelievable beauty and perfect symmetry of the choicer forms. Among the many remarkable things about them is their habit of very freely enclosing within themselves the solvent (air) wherein they form.

This is doubtless largely due to their frequent habit of constantly changing form and acquiring new branches and adornments as growth progresses, accompanied, in many cases, with progressive solidification. The merging of branch with branch and segment with segment as growth progresses and solidification occurs, accomplishes the bridging over and inclusion of tiny quantities of air, and the formation, in many cases, of a vast number of tiny air tubes and chambers, which add vastly to the beauty and complexity of the internal structure.

Figure 23.

The air-tubes possess a further and most fascinating interest, because they outline, in part or whole, transitionary stages of growth, and thus enable us to trace out many of the pre-existing forms of the crystals while growing in cloudland. Another remarkable habit concerns their manner of growth.

The tabular crystals usually grow simultaneously outward, in the form of six-rayed stars, or six-petalled flower-like forms, from a common nucleus. Each of these several parts may, and often does, have but a tiny connection with the others at the nucleus, and hence the whole structure is for all practical purposes, a group of six separately-growing crystals. These rays or segments oft-times undergo a multitude of changes of form, as they momentarily acquire additions here and adornments elsewhere as growth progresses.

But, marvellous to state, growth proceeds, in most cases, after a common plan, as though at the behest of some central controlling influence. A branch or other adornment forming at any given moment and point upon one of the rays or segments, is often instantly and exactly duplicated, as regards time, form, location, and so on, upon all the others, so that perfect symmetry is always maintained.

More marvellous still, growth usually proceeds a little differently in individual cases, so that it is rarely the case that any two are just alike when completed.

A further study and analysis of the forms and habits of growth of these marvellous snow crystals as revealed in the photo-micrographs, and directly under the microscope, discloses much of great interest.

One fact relates to the characteristic manner of formation of the main and secondary rays of the six-rayed starry forms. The secondary rays occur, in general, in pairs, and directly opposite each other upon the main rays. But, strange to say, exceptions are not rare, for we occasionally find secondary rays without corresponding mates on the opposite side of the main ray. It adds much to the interest of these exceptional cases that their frequency increases with distance from the nucleus.

Another interesting thing is the way the secondary rays behave toward each other whenever they grow so far outward as to meet. In most cases, if the rays are short, as when they spring outward and meet close to the nucleus, the tips merely merge, and growth ceases thereafter, in the manner adopted by the first set of branches as shown in Figure 13.

But oft-times in cases in which the secondary rays form far outward from the nucleus, a seeming crossing of the secondary rays takes place, after which each continues growth in the original direction, as shown in Figure 15.

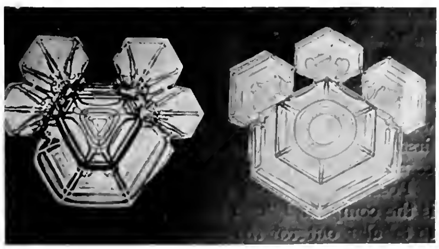


Figure 24.

More rarely [illegible] cause the secondary rays to undergo deflection and increase, the latter in entirely new directions [illegible] shown in Figure 14.

In rare cases, such as [illegible], intermediate [illegible] curvilinear deflection.

Especially mysterious and interesting are those cases in which secondary rays fail to form upon the primary rays, so [illegible].

The mystery is heightened, because in most cases, and even in this, a close inspection of the edges of the primary rays shows that primitive secondary rays formed along the primary ones, but were subsequently either encased in solid layer growth, or failed to increase appreciably. Another mystery concerns the occasional habit some of the secondary rays have, of growing downward or upward, instead of in the usual outward manner. This drooping habit is exquisitely shown in Figure 15.

FIGURE 25.

More puzzling still are those crystals in which, for no apparent reason, secondary rays form only in alternate order, and upon only three of the main rays, producing a trigonal effect so graphically pictured in Figure 17. Odd freak crystals, due in some cases to accident, in others seemingly to design, are not uncommon among the snows of some general storms.

Those of a trigonal shape, Figure 18, those exhibiting a tendency to divide into four or eight, and the odd three or four vaned crystals, and some others, belong in this category. Those having four segments are shown in Figure 19. The most strange and rare freaks are, perhaps, those that undergo a change of type from trigonal to hexagonal, or hexagonal to trigonal, as growth progresses, as shown in our Figures 20 and 21.

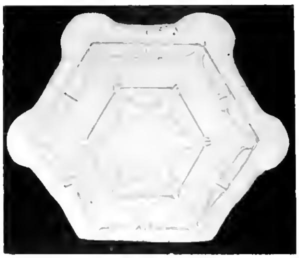


FIGURE 26.

Among the more strange freak tabular crystals are those of chaotic design. Figure 22 is a case in point, in which the several parts are not only unlike and of unequal sizes, but are also attached in irregular order around a central, and irregular, nucleus. Crystals of this character seem to form most frequently within eastern storm segments, when tabular crystals first appear among columnar ones, preliminary to a complete or partial change of type to the former.

Possibly the most singular type due to design, is the compound "cuff button type" (Figure 23), due to tabular outgrowths occurring from the ends, and, more rarely, sides, of columnar crystals.

Doubtless in many, perhaps all, such cases, the columnar part formed first at high and cold altitudes, and the tabular parts later, at some lower cloud level.

Among the more puzzling forms are those exhibiting limited symmetry, and in which one-half or two-thirds of a crystal differs from the other, as shown in Figure 24. The crystals possess such an amazing richness and complexity of interior that scant mention of these features can be made in a single article. Perhaps the most wonderful and inexplicable of these interior features are the tiny sets of clustered microscopic air bubbles which some few of them possess. These usually encircle the nucleus, and are arranged, in some cases, in a symmetrical order perfect almost beyond belief, as shown in Figure 25.

Accidental causes produce many freak crystals. Crystallization often occurs while the crystals are crowded close together, or lie partly embedded in a cluster, so that some parts have free, while others have scant, opportunity of growing. Crystallization, moreover, often occurs upon fractured crystals, upon broken parts, all of which causes tend to produce irregular forms, oblong crystals, and so on.

The latter are oft-times especially interesting, as they show very beautifully the attempt of the crystallizing forces to build up symmetrical structures around imperfect nucleii.

Very interesting are those cases in which two or more crystals grew, in part, while lying close together. The closely lying parts having, of course, less material available and supplied them than the outlying ones, necessarily grow in a stunted manner. In many cases, branches or other adornments acquired elsewhere, failed to form thereon, causing a break in the continuity of the design.

In many cases, however, the crystals seem to attempt to reproduce the general pattern clear around, even though supplied with insufficient material at some points, and do so to the degree that the design, though thinner and smaller, is yet kept, in part at least, intact, as shown in Figure 26. The more perfect crystals of snow are doubtless the most perfect and beautiful examples of Nature's inorganic art and of symmetrical design occurring in Nature. Their value, whether in an educational way as objects for nature and crystallographic study, or in the realm of art, as models for designs in jewellery, metal, wall paper, lace, china, silk goods, and so on, should be very great, and has led already to their being extensively used by universities, museums, schools, lecturers, art craft shops, designers, and so on.

There will doubtless be a great increase, in the future, in the uses to which they will be put, as these bits of pure beauty from the skies become more generally known and more fully appreciated.

SNAKES, BURRS AND BIRDS.

By CUTHBERT CHRISTY, M.B., F.Z.S.

WHILST exploring one of the big forests in Uganda in 1907, I one day told my men that I wanted some puff-adders, two species of which (*Bitis nasicornis*) (see Figure 27), and a much larger one (*Bitis gabonica*), are very common in these forests. Next day I had three or four brought to me, and the following day several more. My intention was to collect a quantity of the venom, and ultimately preserve the skins.

FIGURE 27. The Rhinoceros Viper (*Bitis nasicornis*).

These dangerous snakes are fortunately sluggish brutes, very unlike most of the Indian ones. The largest species, which is sometimes five feet long, is usually found curled up amongst the dead leaves on the ground, where it may, apparently, remain for weeks without moving. I have seen a hundred men in line tread within a foot of one without its taking any notice. Both species have the the power of puffing themselves out, when irritated, to more than double their usual girth, and can strike with tremendous force. The smaller and horned one is more often found amongst the undergrowth, a considerable distance from the ground.

FIGURE 28.

A Burr of *Pisonia aculeata*.

Its length is twelve millimeters.

The facility with which my men procured a number of these poisonous vipers surprised me. On questioning them one said something I could not understand about "birds in the grass"; so next day I went with him into the forest, telling him to take me to where he had found the snakes he had brought. On reaching the place, he pointed out some clusters of a small climbing plant† a few feet off the ground, and not unlike the common woodbine of our hedgerows. On closer examination, I found that the withered parts of the plant bore hundreds of small fruits or "burrs" (see Figure 28), which clung to my coat sleeve and almost anything that touched them ever so lightly.

I was still unable to imagine what possible connection there could be between this plant or its fruits and the snakes; but sure enough we found two puff-adders, and saw other snakes beneath this mystifying plant, although to see a snake in the African forests is not such a very common occurrence.

On returning to camp and going into the matter with an interpreter, I was forced to the conclusion that the plant was able to catch small birds, or at least to so hamper their movements if its "burrs" became entangled in their feathers that they fluttered about on the ground and became an easy prey to the snakes lying in wait beneath, though it seemed crediting the reptiles with extraordinary perspicacity or even some amount of botanical knowledge.

Some months after this, one of my European assistants brought me a bird about the size of a sparrow which he asserted he had caught in the forest with his hands, and which had its wing and body feathers so matted and tangled with these very same "burrs" that it could do no more than flutter about the floor. So that it must be really a fact that these snakes have sufficient intelligence to distinguish in some way either the plant or the locality in which it grows, or else have learnt by experience that that precise spot is one in which small birds, so hampered in their movements that they are unable to fly away, are likely to be found. In Africa the forest natives are full of little items of observation, such as this, that delight the field-naturalist.

FIGURE 29.

A section of the Burr showing the knobs with which it is provided.

* Mr. Raymond Ditmars, author of "Reptiles of the World," says on page 327 of his book that the Rhinoceros Viper is the most beautifully coloured of all snakes. This is his description of a specimen which has recently cast its skin: [illegible]

"Entire upper surface presenting the effect of [illegible] yellow [illegible] and narrowly bordered with the same hue. The [illegible] upright, ruddy-brown triangles, bordered with [illegible] with pale blue. Between [illegible] ground color is rich olive, thickly peppered with black. The head is [illegible] with black dots, and ornamented in the centre with a [illegible] forward; the horns are yellow." [EDS.]

† Dr. Otto Stapf has kindly identified it as *Pisonia aculeata* (Order Nyctaginaceae).

PROFESSOR A. W. BICKERTON

IN the belief that many readers of "KNOWLEDGE" who have studied the recent articles on "The New Astronomy," by Professor A. W. Bickerton, would like to know something about the career of this capable expounder of a new theory of the universe, the few following facts have been collected. They will explain how it happens that the originator of such an epoch-making discovery has remained almost unknown in British scientific circles, whereas had his life work lain in the home country his name would have been familiar in our mouths as household words.

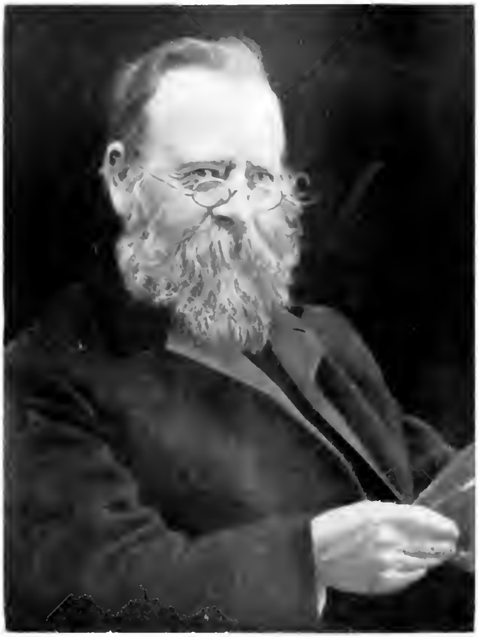


FIGURE 30. Professor A. W. Bickerton.

Alexander William Bickerton comes of an old Cheshire stock and was born at Alton, Hampshire, in 1842. Draughtsmanship is a characteristic of his family; his father at the age of fourteen won the silver palette of the Society of Arts, and later practised as an architectural draughtsman; while a son of Professor Bickerton is an artist.

Educated at Alton Grammar School and intended for a civil engineer, Bickerton entered the Bridgwater Carriage Works of the Bristol and Exeter Railway. Inventiveness soon appeared and in 1864, having devised some machinery for wood-carving, he secured a mill in Painswick, Gloucestershire, in which to develop his ideas. At this time some science classes were being started in the neighbouring town of Stroud and young Bickerton attended these, at the end of the session gaining a first class and the national bronze medal in the Science and Art examination. Being attracted to a scientific career by the enthusiasm of the teacher, he applied himself more closely, and the following year gained further successes in magnetism, electricity, and animal and vegetable physiology. In 1866 he migrated to Birmingham, and while studying for his science teacher's certificate organised and taught in evening technical classes in that city. His workshop experience enabled him to attract artisans to his classes and they became most successful. At this time the regulations of the Royal School of Mines were altered and the examinations that enabled a teacher to obtain the teaching certificate also qualified him for an exhibition at the School of Mines. These regulations were only published thirteen weeks before the examination in 1867, yet purely by private study Bickerton was able not only to pass, but also to secure a Royal Exhibition, and that in a year when the competition was unusually severe. He won three national medals and seventeen Queen's prizes, of which six were first prizes, in various subjects. For the next three years he studied at the Royal School of Mines and the Royal College of Chemistry and utilised his evenings in organising evening technical classes in London. He was actually the first science teacher under the Science and Art Department who succeeded in London after some scores had attempted and failed. It was his classes that originated the gigantic technical educational scheme among the London working classes, and in 1870 Sir Henry Cole, before the Royal Commission on Scientific Education, spoke of him as "a great organiser." In the same year an incident is related by Sir George C. T. Bartley, Bart, in *The Journal of the Society of Arts*, that accounts in some degree for the phenomenal success of these classes through the enthusiasm engendered in the students by Mr. Bickerton. A school was started in Arthur Street, Chelsea, and the premises proving inadequate, others were taken in College Street. These consisted of a disused carriage factory, and funds to fit them for a regular science school being lacking, the students themselves undertook the whole labour of building a lecture amphitheatre with smaller class rooms under part of the raised seats. Carpenters, gasfitters, whitewashers, and other artisans came night after night from six o'clock to eleven and even later. The task took six weeks, and so anxious were the workers to finish it and to resume their classes under Mr. Bickerton that they could hardly be got away each evening until the plan of lowering the [illegible] proved effectual.

Under the chairmanship of the late Sir Charles Dilke, these classes rapidly secured upwards of a thousand students, and became the largest and most successful in the kingdom; while, in spite of this heavy extraneous work, Mr. Bickerton was attaining unique success at the Royal School of Mines. At the end of his first year he won the Senior Royal Scholarship, with 100% of marks in four subjects, and an aggregate of 98% in all—this against such competitors as Professor Sollas, Principal Garnett and Professor Liversidge. Completing his course at the Royal School of Mines and the Royal College of Chemistry he obtained the highest class in all save one subject. Many good offers followed, and he took charge of the science work at the Hartley Institute, Southampton, and also taught at Winchester College and the Training College, and was appointed analyst to the Borough of Southampton, and also to the main division of Hampshire. When Cooper's Hill College was established, the Indian students, who were the mainstay of the Hartley Institute, migrated thither, and Mr. Bickerton, becoming dissatisfied with the unsettled state of the Institute, received offers of many posts, among them being the Professorship of Chemistry at Christchurch (Canterbury College, University of New Zealand).

This offering a more unrestricted and broader field, more leisure and opportunities for original research, Mr. Bickerton finally accepted, the authorities consenting to all the conditions formulated by him as requisite before his acceptance. Accordingly he went there in 1874, and there he worked until 1902, teaching chemistry, electricity and physics, acting as Government analyst, and incidentally giving many public lectures, both technical and popular. His researches have resulted in great pecuniary advantages to the Dominion's industries in many directions.

It was the appearance of Nova Cygni in 1877 that first strongly directed Professor Bickerton's attention to astronomy and particularly to the stupendous nature of temporary stars. From this attention the theory of partial impact and the formation of the third body, so lucidly explained by Professor Bickerton in his articles in "KNOWLEDGE," was evolved.

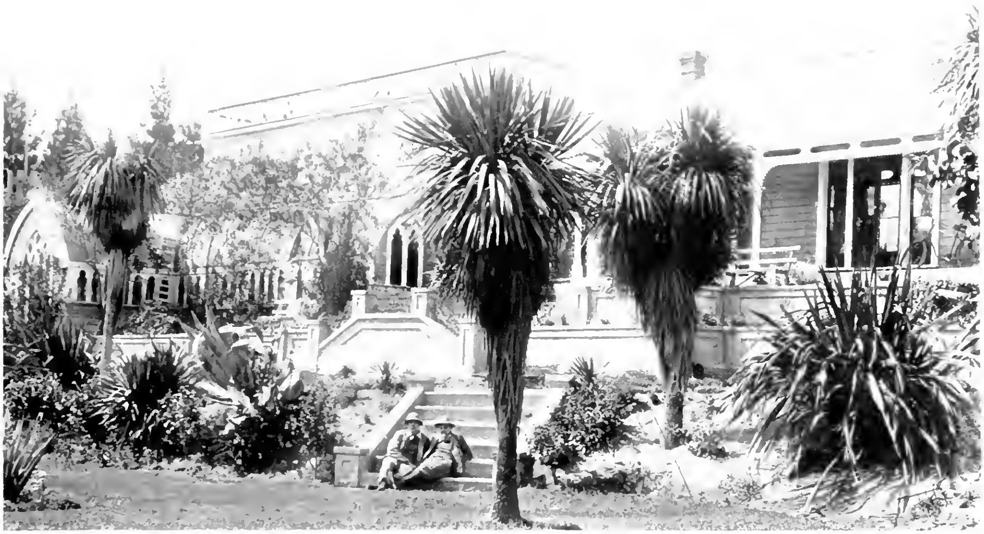


FIGURE 31. Professor Bickerton's Home, Wainoni Park, Christchurch, New Zealand.

Although the formulation of the salient features of the theory, or rather induction, took but a short time, it was some years before the magnitude of the discovery became apparent to its originator, and as its truth was tested in relation to other celestial phenomena than novae it gradually dawned upon him that he had discovered what has been justly called "the master-key to the Cosmos."

His advocacy, however, of this theory outside the College, gave great offence to a certain section of the Board of Governors, and in 1894 and again in 1899 attempts were made to oust him from his position. The first failed lamentably, as at the enquiry it was proved that his students gained more scholarships than all the rest of the colony together and the

H[illegible] student [illegible] on an[illegible] New Zealand. [illegible] ful, as he [illegible] the option [illegible] either his theory or his [illegible] Professor Bickerton [illegible] than his theory, so [illegible] with the University was severed and he was able to devote his time [illegible] to research. Some eight years after [illegible] his chair was [illegible]. At the suggestion of Lord Dudley, then Governor General of Australia, a fund was started; the Board of the very University that had insisted on his resignation took up the project, and the New Zealand Government contributed half the total sum. Thus subsidised, Professor Bickerton was enabled to come to England to [illegible] theory clearly before the scientific world, in the confident hope of securing its general acceptance.

Professor Bickerton's object may be briefly stated as follows:—

To explain his theory of Partial Impact and the formation of the Third Body and the many extraordinary properties it possesses, and to show that cosmic impact is not an accidental and destructive occurrence, but a law of nature brought about by a vast number of agencies, and that it is the most powerful constructive factor in the whole scheme of creation. We believe that all who have carefully read Professor Bickerton's four articles will agree that he has made out a very strong case and that this theory deserves the closest and most sympathetic attention from all astronomers, professional and amateur.

A NATURE CALENDAR BY GILBERT WHITE.

By HUBERT H. POOLE.

GILBERT WHITE, of Selborne, can need no introduction to readers of "KNOWLEDGE," for many of us obtained our earliest natural history impressions from the fascinating pages of that old-time but perennially interesting volume "The Natural History of Selborne."

Gilbert White kept very full records of his observations for over forty years, and his diaries (which have been preserved) begin in 1751 and continue until his death in 1793. For the first thirteen years they are mainly concerned with gardening operations and contain but few notes on wild nature. In 1765, however, a change occurs. White in that year bought a copy of Hudson's "Flora Anglica," beginning in earnest the study of botany, and his notes reflect this new interest; but his ordinary diary for 1766 contains naught but garden observations, all his natural history notes during that year being reserved for a special and unique compilation—the Nature Calendar with which we are now concerned.

The Selborne Society has just published, in facsimile, a reproduction of this interesting work, which is edited by Mr. Wilfred Mark Webb, F.L.S.

In the Introduction it is shown that this record was most probably compiled to form a basis for the "Annus Historico-naturalis" mentioned in White's last letter to Daines Barrington. On the back of the title-page of the manuscript it is called "Flora Selborniensis: with some co-incidences of the coming, and departure of birds of passage, and insects; and the appearing of Reptiles; for the Year 1766." It also contains a number of interesting weather records. From this it will be seen that the work was not intended to deal with plants alone, but forms an exceedingly interesting general Nature Calendar.

The total number of species of plants that White recorded as occurring in the parish of Selborne is four hundred and thirty-nine. In this Calendar for 1766 over four hundred are detailed—a very noteworthy list for one year. Very few records are secondhand, perhaps half-a-dozen; all the rest are the personal observations of the famous naturalist.

An entry for July 2nd is of considerable ornithological interest. It runs "Caught, and ascertain'd the *Regulus non cristatus*. It is a very small bird, but bigger than the golden-crowned wren; pretty common and very mischievous among pease and cherries."

It is well known that White differentiated the Chiff-chaff, Willow-warbler and Wood-warbler which, until his day, had all been lumped together under the name of Willow Wren. This date probably marks his first record of *Phylloscopus* and two years later, August 17th, 1768, he enumerated the three species in a letter to Pennant.

The wrongful accusation that the Willow-warbler is a frugivore, which he reiterated in Letter XVI to Pennant, April 18th, 1768, is a curious error for such a keen observer as Gilbert White to make. The three *Phylloscopi* are now considered to be entirely insectivorous. Harting, however, has suggested that White may have mistaken the young of garden-warblers—which do at times eat fruit, and, as a species, were unknown to White—for willow warblers.

In the ample Index much research has been devoted to the task of supplying the modern scientific names to the plants, birds, insects, and so on, recorded by Gilbert White; but a few still require identification.

One example of these interesting lacunae is to be found on page 58 which we are able to reproduce herewith. No. 272 of Ray's "Historia Insectorum" is doubtless *Eristalis tenax*, but No. 271 is so far unidentified. (See Plate I.)

58. Octob^r 17. Black cluster-grapes are delicate.
Common snake, natrix torquata, still appears.
The blind-worm, or slow-worm, Caecilia, is seen.
Catkins of the alder, alnus, are formed:
The cones are full of seed.
Musca apiformis, tota fusca, caudâ obtusâ, ex
eulâ caudatâ in latrinis degente orta, still is
seen. This fly frequents sinks, & jakes, where it
lays it's eggs. In the autumn it feeds on the flowers
of late annuals, & perennials; & in particular
on the blossoms of Ivy. Ray hist: Insect: 272.
Musca bipennis major, diversicolor, caudâ setis
nigris obsitâ ~~[illegible]~~ appears, & engenders. This
fly is entirely a garden or field-fly, never entring
into houses: it appears to feed on mellow fruit.
M^r Ray seems not to have been aware that it
smells strongly of musk: it might therefore not
improperly be call'd musca moschata. 271.
This seems to be an autumn fly altogether.
20. Common wild service-tree, or Sorb, Mespi-
lus apii folio sylvestris non spinosa, seu Sorbus
torminalis, in fruit; but it is hard, & austere still.
21. Wheat springs out of the Ground.
22. The fieldfare, turdus pilaris, returns.

Page 58 of Gilbert White's Nature Calendar for the year 1766.

THE MILKY WAY.

By Rev. T. E. ESPIN, M.A., F.R.A.S.

In the years from 1891 to 1895 a valuable series of papers were published in "Knowledge" by M. Ranyard, some being contributions of his own, on "The Structure of the Milky Way," others by Messrs. Maunder, Wesley and Sutton; while letters appeared from Professor Barnard and others. The articles were illustrated by photographs of "The Milky Way," taken by Professor Max Wolf, Professor Barnard, and in the South by Mr. Russel. The general result seemed to be that the theories of the past—such as may be summed up as the Cloven Disc theory of Wright, Herschel, Struve, the Spiral Theory of Proctor, or the Double Ring Theory—all failed to explain the phenomena presented by the photographs.

Twenty years have now passed, and during that time many fresh photographs, with various apertures, have been obtained. Professor Wolf has published a complete series of the Milky Way, as visible at Heidelberg, made with a small wide-angled lens, in "Die Milchstrasse," and a great mass of fresh material has accumulated from the photographic researches at Harvard College, and at the Harvard Station of Arequipa. The photo-telescopes of eight-inch and twenty-four-inch aperture, fitted with objective prisms, have been diligently used, and the examinations of the plates by the late Mrs. Fleming have revealed the fact that certain classes of heavenly bodies are found almost without exception in or near the Milky Way. The stars of Type V, the Gaseous Nebulae, the Orion stars with bright lines, the Temporary stars, all tend to arrange themselves in positions of small Galactic latitude. On the other hand, as is well known, "white" nebulae and globular clusters avoid the Milky Way. The stars of Type V show, above all others, not only an affinity for the Galaxy, but for the apparent centre of it. In 1891 our knowledge of the stars of Type V was extremely meagre: there were the original Wolf-Rayet stars in a group in Cygnus; subsequently others were swept up with the spectroscope by Copeland and Pickering. An examination of the photographic plates taken at Harvard and Arequipa have revealed a large number of new ones, and it seems

Figure 32. Aquila.

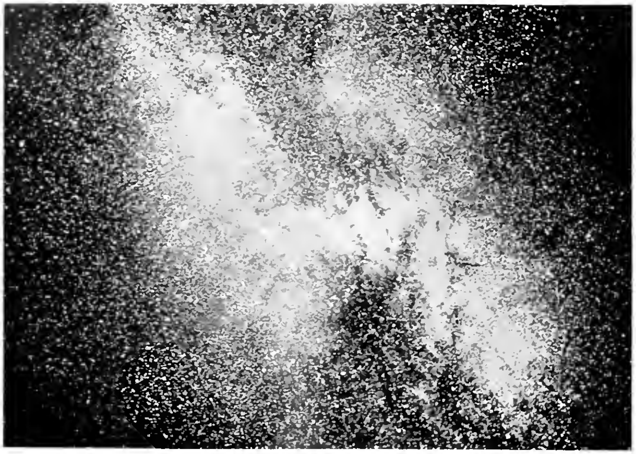


Figure 33. Cygnus.

[illegible] important that all the [illegible] have now been discovered, though fainter ones from time to time are detected. Now, if the stars of type V are plotted down, it is found that they coincide in a remarkable manner with the central circle of the Milky Way [illegible] is this the case that the circle is closely marked

FIGURE 34. Sagitta.

out by them when they are sufficiently numerous, and even where the great bifurcation takes place, these objects persistently follow the centre. The average deviation of the whole number is probably less than two degrees. As Miss Clarke has very truly said, we must believe that the Milky Way is very much as we see it, and that it is not to be explained by two intersecting rings or by spirals. The V-type stars may then be deemed to mark the absolute equator of the Universe of stars. Now in the Southern Hemisphere, near the poles, and quite separated from all apparent connection with the Milky Way, are two cloud-like masses called the Nubecula Major and Minor. Herschel, after examining the Nubecula Major, was clearly of opinion that it was a *multum in parvo* of the visible universe. Here, in the space of a few degrees, are found stars, irregular and globular clusters, nebulae planetary and irregular, all commingled in inextricable confusion. Photographs of the spectra of the objects therein contained, made with the twenty-four-inch Bruce telescope, have confirmed Herschel's dictum by revealing twenty stars of Type V, fifteen objects showing the spectra of gaseous nebulae, and eight Orion stars with bright lines. Comparisons of the plates have further revealed eight hundred and eight variable [illegible]. That these new determinative [illegible] by [illegible] the seeming inextricable confusion may be [illegible] to some sort of apparent order. If the [illegible] showing bright lines are charted, several [illegible] are immediately obvious. There are first of all distinct groupings, the most remarkable [illegible] that connected with the great nebula, 30 Doradûs. In this group, in a circle of one degree, there are six stars of Type V, three gaseous nebulae including 30 Doradûs, and five bright line Orion stars. In the same way the position of N.G.C. 1763 is marked by three stars of Type V, and four gaseous nebulae. Now, if the Nubecula Major really is a miniature universe, there is a strong probability that the stars of Type V mark its equator. Obviously if the Nubecula was situated at right angles to the line of sight, the stars of Type V would tend to arrange themselves in a circle; if, on the other hand, it was inclined to the line of sight, the form would be an ellipse, the eccentricity varying with the inclination. To test this, a chart was made of the Nubecula and affixed to a wall, and illuminated by a light placed some twelve feet away; then between the two was placed a circle of cardboard mounted on a tall stand, and movable round an axis. Repeated trials showed that it was possible to draw an ellipse, with the following

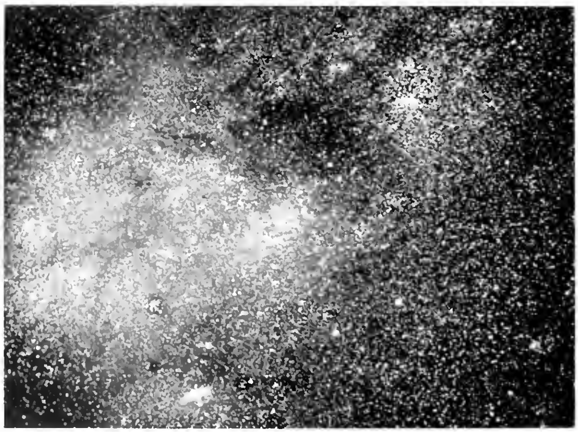
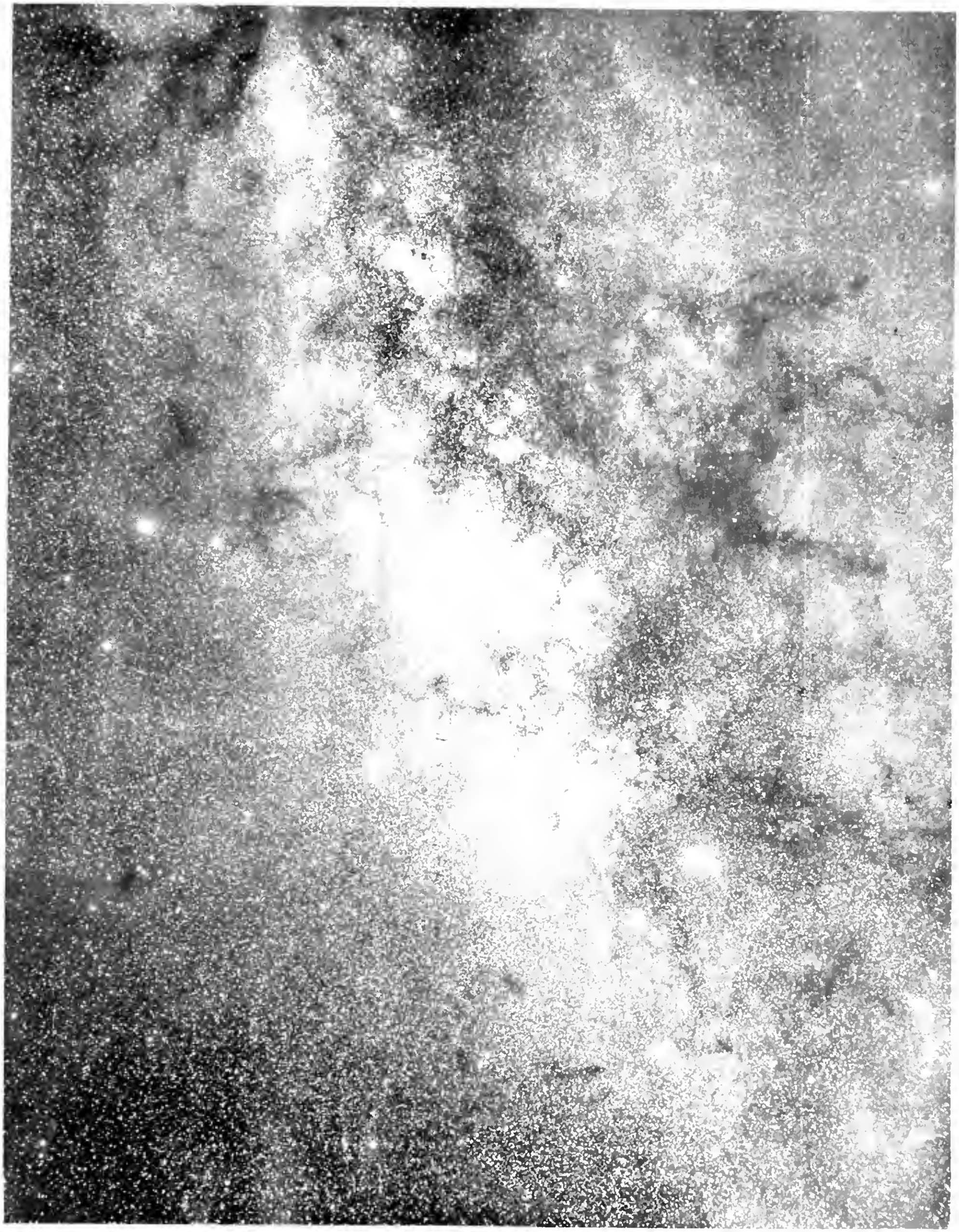


FIGURE 35. Perseus.

results for stars of Type V:

Total number	20
Near ellipse	14
Inside	3
Outside	3

The ellipse was then roughly marked on the



[illegible] Way.

[illegible]

[illegible] at Har[illegible] Ob[illegible]

chart and the following elements obtained:

Semi-major Axis	2° 35'
Position Angle	312
Eccentricity	0·84
Inclination	33°

The pole of the Nubecula points almost exactly at δ Doradûs, and there is apparently a condensation of nebulous objects at the poles. In the Nubecular Minor only one V-type star has been found, but the general appearance suggests a similar construction to the Nubecular Major, with a position angle of about 40°. It is obvious that the mixing up of Galactic and non-Galactic objects must take place as observed by Herschel if the poles of these spheres are inclined to the line of sight. For instance, a V-type star and a "white" nebula may be in the same field, the V-type star being on the equator, while the white nebula is on the opposite side of the sphere, and consequently situated at a distance from the equator.

Having examined this Universe in miniature we may now go on to apply its lessons to the Milky Way. We take a sheet of paper and divide it into squares, and along the top write the hours of Right Ascension, and down the sides the Declinations. Next we lay down the path of the Milky Way according to Gould; then having made a collection of all the known Galactic objects, viz. Type V stars, gaseous nebulae, Orion stars with bright lines, temporary stars, we insert them in their proper places. Immediately it is obvious that the V type stars tend to collect in groups, the two largest groups are in proximity to η Argus and P Cygni, both of which stars have bright lines and have undergone remarkable fluctuations in light. η Argus is associated with a remarkable nebula, and Professor Max Wolf finds vast nebulous patches in the Cygnus region. Further, these places approximately coincide with each end of the great bifurcation of the Milky Way. A glance at our chart shows us also that the V-type stars are much more plentiful in the region between Argo and Cygnus than elsewhere, and further that they tend to follow the medial line, and are grouped upon it at intervals. The gaseous planetary nebulae follow the same law, save that they are more widely distributed, and prefer the following rather than the preceding of the two Galactic streams. The distribution of the Orion stars with bright lines points to the same fact though in a less marked manner, while the temporary stars are more evenly distributed. Taking the percentages of each of these groups we obtain the following table:—

Milky Way	Type V	Plan. Neb	Orion Stars	Temporary Stars
Medial circle	78·8	5·4	15·8	25·0
Preceding stream ...	0	26·8	28·9	40·0
Following stream ...	21·2	67·8	55·3	35·0

If we examine the region from Argo to Cygnus we find in each case the tendency is rather to groups than to uniform distribution. Passing from the great Argo group at Galactic longitude of 255° a group of V-type stars occurs at longitude 275°, a second at 320°. At this spot the planetary nebulae, so far scarce, begin to collect on the following stream of the Galaxy, coming to a maximum at longitude 340°, and here in turn begin the more scattered temporary stars extending up to longitude 360°. The planetary nebulae still continue plentiful up to longitude 30°, then there is apparently a gap till the P Cygni region is reached. Beyond this the Galaxy is singularly poor in bright line objects, and the stars of type V, so far as they are at present detected, disappear altogether between longitude 110° and 190°. Before the latter degree is reached the Orion stars with bright lines begin to appear, and soon become numerous, lying persistently South of Milky Way central line. One group seems connected remotely with the Orion nebula, and a second is found amongst the bright stars which mark the Southern limit of Canis Major. The following table shows in a striking manner the difference between the Argo-Cygnus region and the remaining 213 degrees of Galactic longitude:—

PERCENTAGES.

	Degrees	Type V	Temporary Stars	Plan. Neb	Orion Stars
Argo-Cygnus ...	40·8	81·7	70·8	66·7	55·9
Rest of Galaxy ...	59·2	18·3	29·2	33·3	44·1

Whatever inference we may draw from these results must be carefully guarded with the proviso that it is correct only *as far as our knowledge at present extends*. Some thirty years ago the V-type stars were confined to the Cygnus group; to-day the vast majority are found to extend between η Argûs and P Cygni; but at any rate we seem warranted in drawing the conclusion that in the case of the brighter members in each group of Galactic objects, the ratios of distribution are fairly complete. With increased telescopic power the gaps may be filled up; but it will be with objects fainter than those at present known, and one or two alternations will present themselves, either the causes which produce V-type stars, and so on, are less active in one direction than another, or we are decidedly nearer one section of the Galaxy than we are to the other. At present the general consensus of opinion seems to be in favour of the latter alternative.

Our illustrations show in the large plate the Milky Way from ten degrees to fifty degrees south of the Equator, and the four smaller ones (taken by Professor Wolf with a small lens, and reproduced by his courtesy), carry us north as far as Perseus. Thus they cover the whole of the bifurcation, which, it will be seen, is much more obvious to the naked eye than on the photographic plate. Throughout there will be noticed semicircular dark spaces, probably of absorption matter.

HARMONOGRAPH TRACINGS RECORDED ELECTROLYTICALLY.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc., AND C. W. JUDE, B.Sc.

London County Council Paddington Technical Institute.

ANY form of harmonograph may be used in these experiments. The ordinary tubular writing pen is replaced by a steel needle with its point carefully blunted on a hone so as to have a smooth semi-circular end. This end forms one of the electrodes. The other electrode is a sheet of brass which is fixed firmly to the writing table of the instrument. The electrolyte is a solution of ammonium nitrate and potassium ferro-cyanide in water. The paper upon which the record is to be taken, is soaked in this solution and is then partially dried. The needle is insulated from the harmonograph by being thrust through a cork which fits the holder designed to receive the ordinary tubular pen: it is connected by a very thin wire to one terminal of the source of electric current, while the brass plate upon which the prepared paper is placed is similarly connected to the other terminal.

If direct current is employed an electromotive force of about twenty volts will be found suitable, though this will depend on the kind of paper used, and other circumstances. The provision of a rheostat for regulating the current will be found convenient. When the needle is safely started describing its path on the paper the current is turned on, and is switched off after any desired stage of progress of the record has been attained. By interrupting the current by a clock signal the period of vibration of either pendulum can be determined, or if these periods be known an interrupted trace will serve the purpose of a chronograph record. The direction in which the trace is made by the style can also be recorded by this method. For example, a short interruption followed by a longer one would serve the purpose of an arrow-head on the trace and would indicate the relative direction of motion of the style and paper.

If alternating current is available, pictures like those in the accompanying plate may readily be produced. In this case, the current being reversed many times a second, the electricity is flowing in the direction required to leave a trace, only for a small fraction of a second at a time. The trace then is built up of a series of more or less elongated dots, the intensity of each being greatest in the middle, and shading off to nothing at each end. The number of the dots marked per second is nearly constant, and is equal to the frequency of the alternating supply. It follows from this that the dots are spaced on the trace so as to show by their remoteness or proximity to each other the quickness or slowness of the relative motion of the needle and paper. The velocity of the style with respect to the paper is given in centimetres a second by dividing the frequency of the supply by the number of dots in a centimetre. It will be found that an effective voltage of about forty is suitable for use with paper of the thickness and quality of good unlined foolscap; but again it will be an advantage to have means of varying the voltage so as to obtain the best effects.

As with ordinary harmonograph curves, the more simple ratios of period give the best pictures. Figures i–v are all given by the ratio 2 : 1, the tuning being accurate in Figures iv and v. Figures vi–ix are given by the ratio 1 : 1, the only figure of these in which unison is exact being Figure vi. The initial phase is maintained throughout the diagram in Figures i, iii, iv, v and vi, this being very accurately so in Figures iv, v and vi. In Figure ii, however, the phase difference of the two pendulums is originally similar to that of Figure iv, and finally is like that of Figure i. Figure vi is the only diagram in which the dots are equally spaced throughout one complete oscillation of both pendulums. The velocity in each turn of the spiral is practically constant, but decreases as we approach the centre of the figure. In Figures vii, viii and ix we commence with an approximately circular path, but owing to unequal damping of the two motions, and to change of phase-difference due to inaccurate tuning, the final curve is a much flattened ellipse of different orientation from the original one.

In Figures i and iii it will be seen that the trace was stopped when the left to right motion had almost died away, while the up and down motion was nearly as vigorous as at first. This effect, which may, of course, be shown with any harmonograph, whether the printing be electrolytic or otherwise, can be produced either by using pendulums with bobs of very unequal weight, or by damping the motion of one by means of a flat flexible spring rubbing lightly against the rod of the pendulum so as to press on the rod in a direction at right angles to its motion.

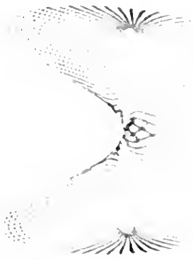


FIGURE I.

FIGURE II.

FIGURE III.

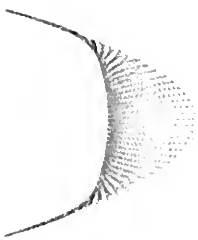


FIGURE IV.

FIGURE V.

FIGURE VI.

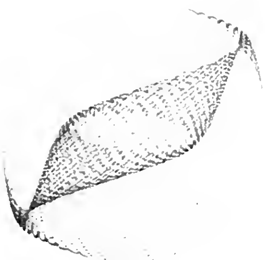


FIGURE VII.

FIGURE VIII.

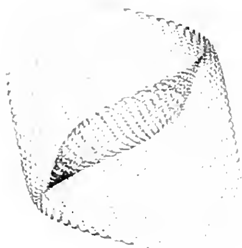


FIGURE IX.

Harmonograph tracings which have been recorded Electrolytically.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed here.

QUESTIONS.

1. ASTRONOMY.—In Sir R. Ball's "Elements of Astronomy," page 390, *re* astronomical constants, a number of quotations are given as to the co-efficients of aberration: the three largest values are those of C. A. F. Peters, 1844, 20"·503; Newcomb, 1895, 20"·511; Maclear, 1850, 20"·530. Have any recent calculations been made giving larger values? In observations regarding aberration so much depends on the allowance made for refraction, even when stars near the zenith are selected, that it is not surprising that Sir R. Ball gives twelve different quotations as to the values. I may observe that a value slightly under 20"·630 would agree with certain other calculations.

W. C. D.

1. ASTRONOMY.—In Sir R. Ball's "Elements of Astronomy," pages 388, 391 and 392, relating to astronomical constants, various calculations are given as to the masses of the earth and moon. The names of the astronomers and the dates of communication, and so on, are given, but not the "elements" by which the calculations were made; viz., parallax of the sun and the parallactic inequality of the moon. Could any of our astronomical friends furnish the information?

W. C. D.

2. METEORITES AND COMETS.—Meteorites, as well as comets, having their defined orbits, and the former, at times, trapped by our atmosphere and destroyed (or attracted to the earth), have, as far as my knowledge goes, never been described as revolving upon their own axis, besides their transitional motion, in order to bring them into harmony with other celestial movements. It would be interesting to know whether any evidence has been forthcoming to show whether this is so or not.

I fully appreciate the difficulty of solving this question, and would also like to know whether the haze round a comet's nucleus has ever been noticed to possess a more or less spiral (revolving) stratification; also, whether the spiral forms, (apparently indicating movement in a certain direction) in various nebulae, have ever been found to have varied in the length of spiral or other signs of such movement.

I would like also to know whether the shape alone of a meteorite in its orbital transit through medium, however tenuous, might not set up and retain a specific revolution.

O. C. J. O.

3. VELOCITY OF LIGHT.—I find the following sentence on page 160 in Sir J. J. Thomson's American Lectures on "Electricity and Matter":—

"It ought to be mentioned that on this view any changes in gravitation would be propagated with the velocity of light; whereas astronomers believe they have established that it travels with a very much greater velocity."

Would some reader of the "KNOWLEDGE" kindly indicate the nature of the evidence upon which astronomers base their belief that gravitation is propagated with a greater velocity than that of light.

M. BLOMQVIST.

REPLIES.

49. POLAR PHENOMENA.—The questions asked by R.K.P. in the September issue demand some space for solution. I shall endeavour, however, to give as brief an investigation as possible.

The following symbols will be used:—

ϕ to denote the latitude of the place.
δ „ „ Sun's declination.
h „ „ „ hour angle.
Z „ „ „ Zenith distance.

Referring to Figure 36, and considering the spherical triangle Z P S we have,

$$\cos ZS = \cos ZP \cos PS + \sin ZP \sin PS \cos h,$$
$$\text{or } \cos Z = \sin\phi \sin\delta + \cos\phi\cos\delta\cos h. \quad (1)$$

Now, as the horizontal refraction is 34′ and as the Sun's semi-diameter is 16′, the Sun's upper edge appears on the horizon when his centre is really 16′ + 34′ = 50′ below it. Making Z = 90° 50′, we have,

$$\cos 90°\,50' = \sin\phi\sin\delta + \cos\phi\cos\delta\cos h,$$
$$\text{or } \cos h = -\tan\phi\tan\delta + \cos 90°\,50' \sec.\phi \sec.\delta. \quad (2)$$

If h = 0, or cos h = 1, the Sun will not rise.
If h = 180° or cos h = −1, the Sun will not set.

(This is evident, since $\frac{2\,h}{15}$ is the number of hours the Sun is above the horizon; when h = 0, this is zero; when h = 180°, it is 24 hours.)

Let h = 0, then from (2)

$$1 = -\tan\phi\tan\delta + \cos 90°\,50' \sec.\phi\sec.\delta,$$
$$\text{or } \cos\phi\cos\delta + \sin\phi\sin\delta = \cos 90°\,50'.$$
$$\therefore \cos(\phi + \delta) = \cos(90°\,50').$$
$$\therefore \phi + \delta = 90°\,50'.$$
$$\text{If } \phi = 86\tfrac{1}{2}°, \text{ then } \delta = 4°\,20'.$$

Therefore the Sun will not rise if his Southern declination is greater than 4° 20′.

If h = 180° or cos h = − 1, we find in the same way that $\cos(\phi + \delta) = -\cos 90°\,50' = \cos(180° - 90°\,50')$,

$$\text{or } \phi + \delta = 89°\,10'.$$
$$\therefore \delta = 89°\,10' - 86°\,30' = 2°\,40'.$$

The Sun will not set, therefore, if his Northern declination exceeds 2° 40′.

In finding the time of continuous long dawn we shall assume that twilight begins when the Sun approaches within 18° of the horizon. The dawn will cease when his upper edge appears on the horizon, as daylight commences then.

Referring again to our first equation, we see that Z S = 90° + 18° = 108° when dawn commences.

Also if h = 180° or cos h = − 1, twilight will continue all night, since $\frac{2\,h}{15} = 24$ hours.

Making these substitutions we find,

$$\cos 108° = \sin\phi\sin\delta - \cos\phi\cos\delta = -\cos(\phi + \delta),$$
$$\therefore \cos 108° = -\cos(\phi + \delta) = \cos(180° - \phi - \delta),$$
$$\therefore 108° = 180° - \phi - \delta,$$
$$\text{or } \delta = 72° - \phi.$$

Therefore, if δ = or > 72° − ϕ, twilight will continue all the night, even at the time of greatest depression, *i.e.*, 18° below the horizon: hence, $\delta > 72° - 86\tfrac{1}{2}° > 14\tfrac{1}{2}°$ S. We have seen that the Sun will just commence to rise when his Southern declination is less than 4° 20′. The twilight, or continuous dawn will, then, endure while the Sun changes from $14\tfrac{1}{2}°$ S to 4° 20′ S.

[illegible]

[illegible]

[illegible]

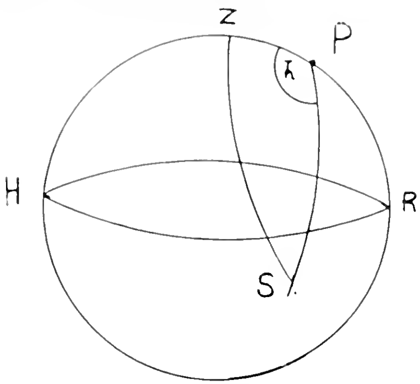


FIGURE [illegible].

[illegible] S. The continuous dawn has then commenced. On March 11th, at noon, his declination is 4° 2′ 24″ S., so that twilight has commenced some time previous to this. The interval is about 28½ days. If, however, we take 17° as the angle below the horizon when twilight starts, we should reckon from 13° 30′ S. This would reduce the time of continuous dawn to 25½ days. It is easily seen from this how impossible it is to give the time of continuous dawn exactly, because the angle below the horizon varies with circumstances, such as atmospheric conditions, and so on. It is not exactly 18° under all circumstances.

On March 28th, at noon, the Sun is just short of 2° 40′ N. by 30″·7. Practically, then, we may say that the long day has commenced on March 28th. Reckoning from March 11th to March 28th, we obtain about 17 days as the time of alternation of sunshine and dawn.

On September 17th, about 8 a.m., the Sun has again attained a declination of 2° 40′ N. The time from March 28th to September 17th is 173 days. But we must deduct slightly from this, because we have assumed daylight to start the instant the upper edge of the Sun appears above the horizon. We must allow a little time after this before the long day actually commences.

For the reasons just given, we can only obtain an approximation to the number of days in each period. The figures may vary slightly according to local conditions. If we adhere strictly to the above reasoning, a latitude 86° 8′ N. gives 171 days for the long day. Probably 86° [illegible] N. most nearly fulfills all the conditions, because a less latitude than 86° N. increases the time of alternation of sunshine and twilight.

It may be interesting to notice that in Lieutenant Shackleton's book, "The Heart of the Antarctic," it is mentioned how the Sun was seen for the last time in 1908, on April 27th, when one third of the disc was above the horizon at noon. He was seen again first on August 17th, when his entire disc was above the horizon, and the lower edge one fourth his diameter from it. He could, it is stated, have been seen a day or two earlier if the day had been clearer. The latitude was 77° 30′ S. This fact shows how difficult it is to predict [illegible] and [illegible] the result.

[illegible] and that his apparent diameter [illegible] 32′, he [illegible] on two days [illegible] above the horizon. If [illegible] we substitute 4° [illegible] for δ, the declination on [illegible] and 90° 50′ for Z, and [illegible] for h, we find

[illegible] 15 [illegible] hours. The total length of the day [illegible] twice this, since the increasing declination makes [illegible] longer than the morning. His upper edge is above the horizon for a longer time than 5 hours 9 minutes on [illegible] day.

For the next day we find the time to be 4 hours 50 minutes, and for the next 6 hours 8 minutes. The whole number may be easily worked out from the formula. In these examples we assume δ to be that of noon, and neglect its small change in the time. Of course these times vary from year to year, as the Sun will not attain to precisely the same declination on the same day each year. The first day would be 1½ hours long, if the Sun's declination were somewhat less than 4° 2′ 24″.

If we reckon the time from which the Sun actually attains 4° 2′ S., that is, on March 10th at 6 p.m., to the time when he enters the Vernal Equinox, that is, 6 p.m. on March 21st, the interval is 11 days. From a few calculations we find the change of longitude in the time to be 10° 55′. If this time on March 10th correspond with the instant the Sun is in the constellation mentioned, 129°, then at Vernal Equinox we shall have 129° + 10° 55′ = 139° 55′, differing by 5′ from the longitude given. This difference corresponds with a time of about 1 hour 12 minutes, so that the calculation by "Baroda" is practically correct for this period.

If some light were thrown on the precise time these phenomena occurred, it would simplify the calculations asked for with reference to New Moon, and so on.

(REV.) M. DAVIDSON.

51. GEOLOGY OF SOUTH DORSET (ISLE OF PURBECK). The geology of this district offers wide scope for practical field geology on account of the number of strata which are so well exposed in coast sections. A detailed account as suggested by S.P.R. would necessitate quite a lengthy article to deal at all adequately with the geology from the point of view of strata alone, without mentioning fossils and minerals.

The chief places of interest in the locality are as follows:

(1) Durlston Bay, where a splendid section of the Purbeck beds is exposed, and in fact duplicated in part by a fault.

(2) Swanage Bay, with Upper Purbeck at Peveril Point, Wealden, Lower Greensand, Upper Greensand and Chalk at the more northerly end of the bay.

(3) Studland Bay, with Upper Chalk and Bagshot sands.

(4) St. Alban's Head and Chapman's Pool, with Portlandian, Purbeck and Kimmeridge Clay.

(5) Kimmeridge Bay, where many faults almost diagrammatic in their distinctness may be seen.

(6) Lulworth Cove and Stairhole, showing steps in Cove formation and strata compressed and contorted.

(7) Durdle Cove, showing further stages of coast erosion and cove formation.

(8) Bournemouth, with Bagshot and Bracklesham Beds containing noted leaf beds.

I would suggest that S.P.R. should purchase "The Guide to the Geological Model of the Isle of Purbeck," by Aubrey Strahan, M.A., F.R.S.; Price 6d. Publishers: E. Stanford, 12, 13 and 14, Long Acre, London, which gives an interesting and useful account of the district required.

HERBERT E. TAYLOR.

THE FACE OF THE SKY FOR FEBRUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

[illegible]
[illegible]

Table 1.

[illegible]
[illegible]

Table 2.

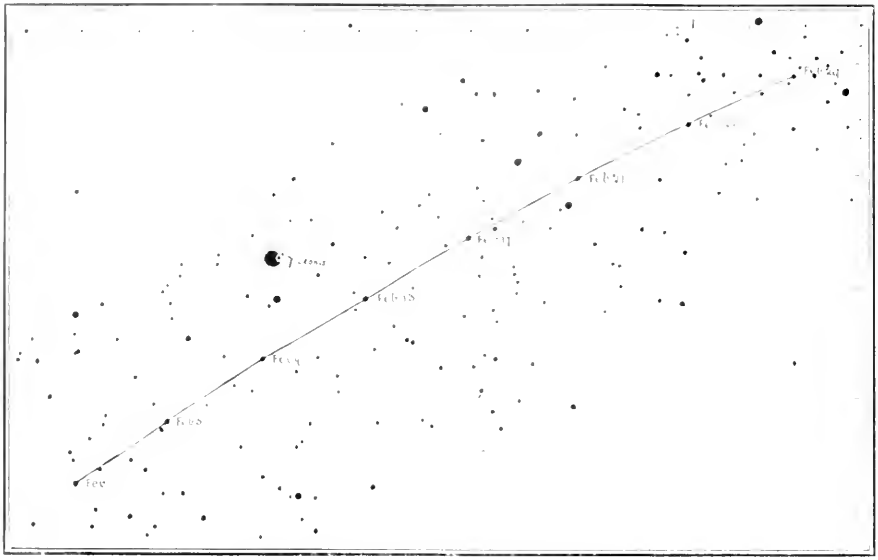
P denotes the position angle of the axis of the body measured eastward, from the North Point of the disc. B is the Heliographical (Planetographical) latitude of the centre of the disc. L denotes the longitude of the centre of the disc, T the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter there are two systems of longitude, I. for the equator, II. for the temperate zones. To find intermediate values of T apply multiples of $24^h 39^m$, $9^h 50\frac{1}{2}^m$, $9^h 55\frac{3}{4}^m$ for Mars, Jupiter I and II, respectively. Throughout these notes the time used is Greenwich Civil Time, day commencing at midnight, and the letters *m*, *e*, stand for morning and evening. Q, q, for Mars are the position angle and amount of the greatest defect of illumination.

The Sun moves North fairly rapidly during February. His semi-diameter diminishes from 16′ 15″ to 16′ 10″. Sunrise and sunset at Greenwich, Feb. 1, $7^h 43^m$ *m*, $4^h 45^m$ *e*; Feb. 29, $6^h 50^m$ *m*, $5^h 36^m$ *e*.

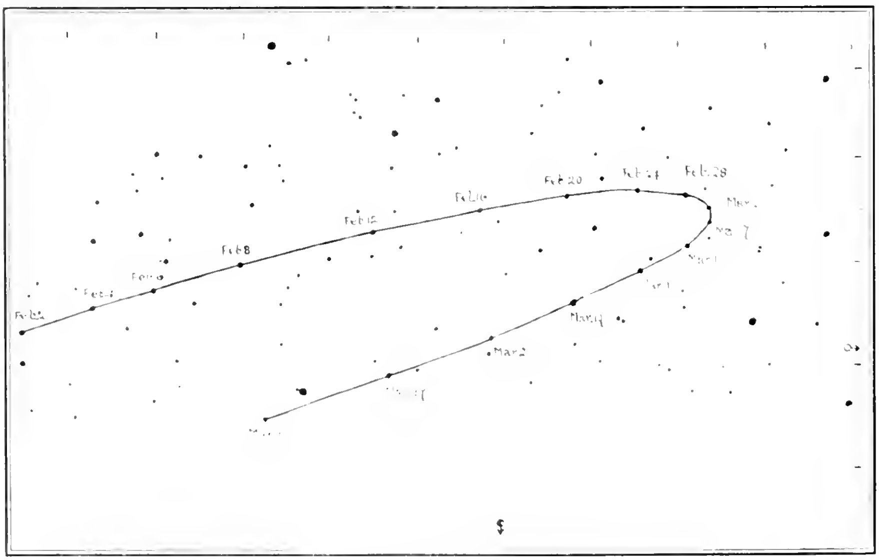
The Moon is Full, Feb. 2^d $11^h 58^m$ *e*; Last Q., Feb. 10^d $0^h 51^m$ *m*; New, Feb. 18^d $5^h 44^m$ *m*; First Q., Feb. 25^d $7^h 27^m$ *e*; Nearest Earth, Feb. 2^d 2^h *m*, semi-diameter 16′ 42″·8; Furthest away, Feb. 14^d 11^h *m*, semi-diameter 14′ 44″·3; Nearest March, 1^d 9^h *m*, semi-diameter, 16′ 30″·4. Greatest Libration 7° S. Feb. 1; 7° W. Feb. 7; 7° N. Feb. 15; 6° E. Feb. 23; 7° S. Feb. 28. The letters N. E. S. W. indicate the region of the Moon's limb (referred to our sky) carried into view by libration. Observers should watch their librational opportunities to increase our knowledge of the regions near the limbs.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h m		h m	
Feb. 1	47 Geminorum	5·6	4.15 *m*	59	4.45 *m*	335
,, 1	BD + 20° 1481	7·0	4.23 *m*	150	—	—
,, 1	ω^1 Cancri	6·1	8. 9 *e*	68	9. 6 *e*	312
,, 1	ω^2 Cancri	6·2	8.35 *e*	125	9.37 *e*	259
,, 2	BD + 24° 1903	7·0	4.41 *m*	40		
,, 2	λ Cancri	5·9	5.10 *m*	54	5.39 *m*	345
,, 3	BAC 3443	6·3	8.16 *e*	123	9.16 *e*	280
,, 4	BAC 3759	7·0			8.13 *e*	337
,, 6	BAC 4083	7·1	—	—	6.15 *m*	183
,, 8	86 Virginis	5·6	6.24 *m*	154	7.25 *m*	208
,, 11	BAC 5403	6·9	5.38 *m*	103	7. 1 *m*	299
,, 13	BAC 6072	5·8	—		5.25 *m*	288
,, 24	τ^2 Arietis	5·2	8.31 *e*	85	9.34 *e*	242
,, 24	65 Arietis	6·6	9.23 *e*	98	10.19 *e*	232
,, 27	BAC 1754	5·7	2.30 *m*	131	3.13 *m*	231
,, 28	BD + 27° 1104	6·9	0.41 *m*	165		
,, 28	BD + 27° 1104	7·7	2.39 *m*	164	—	
,, 29	*e* Geminorum	5·5	1.14 *m*	114	2.10 *m*	281

Table 3. Occultations of stars by the Moon visible at Greenwich.



F[illegible] Th[illegible] Path [illegible]f Vesta [illegible] February, 1912.
Th[illegible] S[illegible] [illegible] ½.



F[illegible] [illegible] February and March, 1912.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle.	Distance.	Colours.
	h m	° ′		°	″	
Struve 1024	7 4	38 18 N	8·3, 8·8	316	1	Yellow, white.
" 1037	7 7	27 25 N	7·1, 7·1	295	1	White.
" 1051	7 10	73 15 N	6·5, 8·6	282	1	Triple, white.
			6·5, 6·7	82	31	
" 1055	7 15	[illegible] 5 N	6·0, 10·5	324	2	White.
λ Geminorum	7 13	16 42 N	3·2, 10·3	33	10	Bluish green.
19 Lyncis	7 16	55 27 N	5·3, 6·6	315	15	Bluish-white.
20 Lyncis	7 16	50 10 N	6·6, 6·8	254	15	White.
δ Geminorum	7 15	22 0 N	3·2, 8·2	200	7	Yellow, blue.
Struve 1083	7 2[illegible]	20 40 N	6·8, 7·8	43	6	Yellow, blue.
" 1097	7 24	11 23 S	6·3, 8·2	160	1	Quadruple.
			6·3, 8·7	313	20	
			6·3, 10·6	157	23	
" 1104	7 25	14 40 S	6·7, 8·3	332	2	White.
Castor	7 29	32 5 N	2·7, 3·7	222	5	Yellowish green.
Struve 1110	7 29	12 20 N	7·0, 7·7	100	2	White.
" 1121	7 33	14 18 S	7·2, 7·5	304	7	White.
" 1122	7 38	05 22 N	6·8, 7·0	5	15	White.
" 1126	7 35	5 20 N	7·2, 7·5	145	1	White.
			11′ East of Procyon.			
" 1127	7 39	64 17 N	6·2, 8·5	338	5	Triple.
			6·2, 9·0	175	11	
" 1138	7 40	14 28 S	6·2, 7·0	339	17	White.
" 1149	7 44	11 59 S	5·3, 7·4	13	3	Yellow, blue.
" 1177	8 0	27 49 N	6·5, 7·4	352	3	Bluish white.
" 1178	8 4	32 20 N	7·1, 8·0	40	2	Yellow.
ζ Cancri	8 7	17 55 N	5·0, 5·7	2	1	Triple.
			5·0, 5·5	114	5	
Struve 1216	8 17	1 10 S	7·5, 8·2	215	½	White.
φ² Cancri	8 21	27 14 N	6·0, 6·5	217	5	Yellowish.
ι Cancri	8 21	24 50 N	6·0, 7·1	41	6	White.
Struve 1245	8 31	6 30 N	6·0, 7·0	25	10	White.
" 1263	8 39	42 1 N	7·0, 8·2	22	60	White.
		An optical double.	7·0 has large proper motion.			
ι Cancri	8 41	29 6 N	4·4, 6·5	307	30	Yellow, blue.
ε Hydrae	8 42	6 45 N	3·8, 7·8	222	¼	Quadruple.
			3·8, 8·5	231	4	
			3·8, 12·0	105	20	
σ² Cancri	8 49	30 50 N	5·9, 6·4	320	1½	Yellow.
66 Cancri	8 59	32 30 N	6·1, 8·2	138	4	White, blue.

FIGURE 4. Double Stars between Right Ascension 7^h and 9^h.

MERCURY is badly placed for Northern observers, but may be seen as a morning star at the beginning of the month. It presents a nearly full disc, being in superior conjunction on March 1st. It is on the same parallel as Venus on February 4th, and may be found by pointing a telescope at Venus, and leaving it stationary for 1^h 24^m.

VENUS is also rather badly placed, being South of the Sun; ⅘ of the disc is illuminated, the diameter diminishing from 14½″ to 12½″.

MARS is still a bright evening star in Taurus, but is rapidly receding from us. The diameter diminishes from 10″ to 7″. The seasons on the planet correspond to the first half of April on Earth. Both poles are invisible, since the Sun and Earth are on opposite sides of the planet's equator.

CERES and VESTA are both well placed, the latter being in opposition on February 16th. Its magnitude is 6½, so that it might be glimpsed by a keen eye without optical aid. The positions of the two planets are sufficiently shown by maps indicating the configuration of surrounding stars. Vesta is 50′ South of η Leonis, on February 9th.

JUPITER is better placed than last month, but its South declination is a drawback to Northern observers. The equatorial diameter increases from 34″ to 36½″. The polar is 2¼″ less. Defect of illumination nearly ¼″. The diagram shows the configurations of the four large Satellites at 5^h *m.*

Day.	West.		East.		Day.	West.		East.	
Feb. 1	3	⊙	24		Dec. 16	32		4	1●
" 2	32		4		" 17	31		4	2●
" 3	41		2		" 18			124	
" 4	4		13		" 19	12		43	
" 5	41		3		" 20	4		13	
" 6	42		13		" 21	41		32	
" 7	413		2		" 22	43		12	
" 8	43		12		" 23	432			1●
" 9	42		1		" 24	432	⊙		
" 10	41			2●	" 25	4		12	
" 11			4132		" 26	41	⊙	3	
" 12	12		43		" 27	24		13	
" 13	2		134		" 28	1		24	
" 14	1		324		" 29	3		124	
" 15	3		124						

TABLE 5.

Phenomena visible at Greenwich:—I. Sh. I. 1^d 4^h 12^m, II. Sh. I. 5^h 16^m, I. Tr. E. 5^h 18^m; II. Oc. R. 3^d 4^h 30^m; III. Ec. D. 7^h 30^m 22^s; III. Tr. E. 7^d 3^h 43^m, I. Ec. D. 6^h 43^m $5[illegible]^s$; I. Sh. I. 8^d 3^h 52^m, I. Tr. I. 5^h 1^m, I. Sh. E. 6^h 5^m, I. Tr. E. 7^h 14^m; I. Oc. R. 9^d 4^h 32^m; II. Oc. R. 10^d 7^h 10^m; III. Tr. I. 14^d 5^h [illegible]; I. Sh. I. 15^d 5^h 45^m, I. Tr. I. 6^h 57^m; I. Ec. D. 16^d [illegible]; I. Oc. R. 6^h 29^m; I. Tr. E. 17^d 3^h 39^m, II. Ec. D. 4^h [illegible]; II. Tr. E. 19^d 4^h 52^m; III. Sh. I. 21^d 5^h 5^m, III. Sh. E. [illegible];

[illegible] E., [illegible] E. [illegible] R. [illegible] H. [illegible] H. S. [illegible]. The above are all the ... phenomena [illegible] ... direction of the [illegible] IV does not undergo eclipse at present.

SATURN [illegible] Equatorial [illegible] Major [illegible] following [illegible] Satellites. [illegible] multiple of [illegible] for Tethys, [illegible] 18h for Dione, [illegible] for Rhea.

Tethys Feb. [illegible] 11h [illegible] 7d [illegible] 13d 7h *m*; 18d 11h [illegible] *m*. Dione Feb. 1d 5h [illegible] 7d 5 *m*. [illegible] *m*. 23 [illegible] 29 [illegible] *m*. Rhea Feb. 1d *noon*, [illegible] 19 [illegible] 28d [illegible]. For Titan and Iapetus E., W., denote East and West Elongations, I.S. Inferior and Superior Conjunctions. Titan Feb. 2 [illegible] *m* E. 6d 4 *m* W. 10d 2h *m* S. [illegible] *m* E. 18d 7h *m* E. 22d 4 *m* W. 26 2 *m* S.; March 1d [illegible] *m* E. Iapetus Feb. 5d 8h *m* W. 24d 5 [illegible] S.

URANUS remains invisible.

NEPTUNE is very well placed in Gemini. The map given last month is still available for finding it.

COMETS. Ephemerides for three comets in February were given last month. Prolonged observation of Quénisset's comet is desirable, as it may possibly be identical with 1790, III.

METEORS. Mr. W. F. Denning gives the following showers.

Date.	Radiant. R.A.	Radiant. Dec.	Notes.
[illegible]	7[illegible]	[illegible] N.	Slow, [illegible]
15	136	11 N.	Swift, streaks.
15	161	4 N.	Swift, [illegible]
[illegible]	184	4 N.	Swift, [illegible]
[illegible]	193	9 N.	Swift, [illegible]

M[illegible] Algol. Feb. [illegible] 10h 5 *m*. [illegible] Period 2d 20h 49m. Every 3rd minimum given.

CLUSTERS AND NEBULAE.

Name.	R.A.		Dec.		Notes.
	h	m	°	'	
H IV. 45	7	23	21	7 N.	Nebula.
H VI. 1	7	32	21	48 N.	Cluster.
H VIII. 38	7	32	14	13 S.	Loose cluster.
H VI. 37	7	35	10	28 S.	Cluster.
M. 46	7	37	14	34 S.	Cluster.
H IV. 64	7	38	17	56 S.	Planetary nebula.
M. 93	7	40	23	35 S.	Cluster.
H VII. 11	8	6	12	30 S.	Loose cluster.
H VI. 22	8	9	5	28 S.	Cluster.
M. 44	8	34	20	20 N.	Praesepe cluster.
M. 67	8	46	12	13 N.	Cluster.

MATHEMATICS AND PHYSICS IN THE ENCYCLOPAEDIA BRITANNICA.

THE eleventh edition of the "Encyclopaedia Britannica" is of a vintage, which, judging from the initials of the contributors of its articles on mathematical and physical subjects, needs a bush no more than the ninth edition. Bush or no bush, such a production cannot pass unnoticed, though to discuss adequately even one group of articles is beyond the powers of this reviewer, even if the attempt were not beyond the scope of this journal.

Mathematics and physics have always been special features of this work, and in the present edition the compilers have kept this fact in mind. There is not in English, as there is in French and German, a Dictionary or Encyclopaedia of Mathematics, and the eleventh edition of the "Encyclopaedia Britannica" aims definitely at supplying this need. This means that a large number of new articles have been written, while a few of the older articles re-appear. Among these, of course, we find treatises by such men as Cayley and Tait, which have become in a measure classical. On the other hand we have our attention called to the modern trend of mathematical thought by the new article "Mathematics." This, contributed by A. N. Whitehead, takes the place of Professor Chrystal's article. The same author, with Mr. Bertrand Russell, contributes sections under the heading "Geometry," an article which combines old and new. Professor O. Henrici discusses Euclidean, Prospective, and Descriptive Geometry, while Cayley's Analytical Geometry has been revised by Professor E. B. Elliott. Among other contributors in Pure Geometry we notice the names of E. W. Hobson, A. E. H. Love and H. F. Baker. In Applied Mathematics Professor H. Lamb, Sir George Greenhill, and Sir George Darwin, are noteworthy contributors. Physical Science moves so fast now-a-days that a treatise may become out of date in the course of its preparation for the press. We refer, of course, more particularly to the rapid growth of the new study of radio-activity. But the new views on the structure of matter are bound to have their effect in all branches of Physics. In the eleventh edition the group of articles of which the Properties of Matter and the Aether form the theme are particularly noteworthy. Part of Clerk Maxwell's famous article "Atom" can never be out of date, and reappears under the heading "Molecule." The present occupant of Maxwell's chair, Sir J. J. Thomson, contributes a new article "Matter." Sir Joseph Larmor's "Aether" contains all that was valuable in Maxwell's "Ether" modified in accordance with the prevalent views.

More of Maxwell's distinctive work reappears in Lord Rayleigh's "Capillary Action" and Professor G. H. Bryan's "Diffusion." Lord Kelvin, the last survivor of the great "Early Victorian" group of Cambridge Physicists, contributed two famous articles to the ninth edition: "Elasticity" and "Heat." He survived long enough to be consulted with regard to these, and there can be no question that in handing over to Professors A. E. H. Love and H. L. Callendar the task of bringing them up to date, he made an admirable choice. In the region of "Light" Lord Rayleigh is fortunately still with us, and his new articles on "Diffraction" and "Interference," both of them experimental as well as mathematical, take the place of his former "Wave Theory" and Professor Tait's "Light." The remarkable advance in optical instruments due to the work of Abbé and Schott finds recognition; and articles on "Lens" and "Aberration" have been contributed by members of Zeiss' staff at Jena.

In Electricity and Magnetism a noteworthy transformation has been made. Professor G. Chrystal, of Edinburgh, taken by death from his work since these pages came into the reviewer's hands, was the author of the articles in the ninth edition, which were regarded as the best existing text-book of the "eighties." In their place we now find a series of articles by Professor J. A. Fleming, Sir J. J. Thomson and others, which are as far as possible up-to-date, and which by their headings and arrangement simplify the process of reference. As an example of the difficulty of keeping abreast of the times in such a work as this the reviewer may mention that he has been unable to find either under the heading "Compass" or "Gyrostat" any reference to the Gyrostatic Compass.

REVIEWS.

AERONAUTICS.

Natural Stability in Aeroplanes. By W. Le Maitre. 46 pages. 33 illustrations. 7½ in. × 4¾ in.

(E. & F. N. Spon. Price 1/6.)

This book is the expression of the personal opinion of the author on the subject forming the title. There is also a rough description of a machine designed in accordance with principles which he has deduced from experiments made with small gliders.

His main deduction is that machines with short wing span and low centre of gravity will make the best and most "efficient" machines.

The author seems to be under the impression that his principles have never been tried: he is very much mistaken on this point.

As to the deductions themselves, short span and very low centre of gravity are almost diametrically opposed to the generally accepted necessary conditions for proper efficiency, and the propriety of these conditions, besides being demonstrable by laboratory experiment, is fully confirmed by the results in practice.

It is also a fairly well-known fact that by increasing or adding to the resistances of an aeroplane, one can increase its stability, but at the expense of its efficiency or the power necessary for flight.

The only proper deduction from the author's experiments is that a machine constructed to the author's designs, when once up, could, on a very calm day, form a steady glide to earth, (somewhat steep, very possibly), but that such an inefficient machine ever would "get up" is, to say the least, problematical.

T. W. K. C.

Langley Memoir of Mechanical Flight.

(Published by the Smithsonian Institution, Washington).

In this book we have the long looked for full description of all the wonderful and patient experimental work of the late Mr. Langley. The work, which has taken eight years to complete, is a monument to the single-minded thoroughness of the experimenter, and to the untiring energy of his most able assistant, Mr. Manley, and the result far exceeds the most sanguine expectations.

The size of the work precludes any adequate description of its contents; suffice it therefore to remark that it consists of over three hundred pages of text, written in a clear, concise and interesting manner, and well printed on good paper. There are in addition one hundred and one full page plates, all clearly reproduced from photographs. These shew various rubber driven models (there are thirty-one of these), power models (four of these), the same in flight, launching apparatus, man-carrying machines, surfaces, automatic equilibrium devices, boilers, and numerous others, most of them having their details shewn separately.

Here may be read the troubles attendant on making light motors, and how, (in 1900), when searching over Europe for a light petrol motor, all the builders were agreed that a light twelve horse-power motor could not be built to weigh less than two hundred and twenty to three hundred and thirty pounds, and how finally Mr. Manley personally assumed the responsibility of making the same, and successfully produced one of twenty-four horse-power weighing one hundred and twenty pounds only, a result comparable with present engines.

To those who interest themselves in "Flight" this book is essential.

T. W. K. C.

CHEMISTRY.

The Relative Volumes of the Atoms of Carbon, Hydrogen and Oxygen, when in Combination. By Hawksworth Collins, B.A. (Cantab.). 107 pages. 8½-in. × 5½-in.

(Morton & Burt. Price 7/6 net.)

To Hermann Kopp is due the honour of having made the first systematic attempt to discover the relation between the chemical constitution and the physical properties of bodies. Amongst these properties he gave perhaps greatest attention to that of molecular volume. He concluded that molecular volume is an additive property, *i.e.*, that the volume of an atom in combination is a fixed quantity (within certain limits) at any temperature, and that the volume of any molecule is the sum of the volumes of its constituent atoms. He assigned the following values to the atoms of Carbon, Hydrogen and Oxygen C = 11; H = 5·5; O = 12·2 or 7·8 according to whether it is carbonyl oxygen or hydroxyl-oxygen. Researches carried out since the time of Kopp have shown that the matter is not so simple as this; the arrangement of the atoms has a decided influence upon the molecular volume, (as Kopp recognised in the case of oxygen), isomeric bodies by no means always having the same molecular volumes.

The author of the present work has given many years of study to the solution of this problem, seeking for some consistent method of interpreting the values for the molecular volumes of various compounds obtained by experimental chemists. And as a result of this study, he has devised a method of calculating the molecular volumes of various bodies with a quite remarkable degree of accuracy. In the present work he deals only with compounds containing carbon, hydrogen and oxygen. He finds that the molecular volumes of such bodies at 15 C may be calculated by giving the following values to these atoms C = ·71, or in some cases 8·0; H = 15·25, 12·22, 9·95, or 5·76; O = 2·51, 4·45 or 7·53; the different values of the elements being assigned according to certain fixed rules.

The fact that it is necessary to give different values to the atoms of hydrogen and oxygen, he explains by the theory that the four valencies of carbon are not equal, and that the volumes of other atoms differ according to which carbon valence they are combined with. There are immense difficulties in the way of accepting this theory, however, and the fact discovered by Mr. Collins, that in order to calculate accurately the molecular volumes of carbon compounds we must assign differing values to the hydrogen and oxygen atoms may be explained otherwise, and we think, more easily. For, in the first place, there is the probability that the volume occupied by an atom is affected by neighbouring atoms; and, in the second place, we have shown elsewhere ("On the Calculation of Thermo Chemical Constants") that the true atomic values for any physico chemical property are unobtainable in the present state of knowledge, the supposed atomic values obtained being really the differences between the values of such atoms and their linkages and the influences due to the linkages broken by the introduction of these atoms into the molecule. Regarding Mr. Collins' values of the atomic volumes as the values of such differences, his work is of considerable worth. So little is really known of what may be termed the physics of molecules, that every addition to this subject is especially welcome. Physical chemists will doubtless give Mr. Collins' interesting book the careful attention it deserves.

H. S. Redgrove.

EVOLUTION.

The Mutation Theory. Vol. II. The Origin of Varieties by Mutation. By Hugo de Vries, Professor of Botany at Amsterdam. 683 pages. With 149 figures and six coloured plates. 9¾-in. × 6-in.

(Kegan Paul, Trench, Trubner & Co. Price 18/- net.)

The principal features of the theory of Mutation were dealt with at length by Professor de Vries, in his two volumes published in German in 1901 and 1903, in which he endeavoured to present as completely as possible the detailed evidence obtained from trustworthy historical records, and upon his own experimental researches, on which the theory is based. In 1904, Professor de Vries delivered a course of lectures on this subject in English, at the University of California, at Berkeley in that State, in which those points were emphasized most suitable for scientific demonstration to a class of advanced students.

The present volume is a translation by Professor J. B. Farmer and Mr. A. D. Darbishire, of the second volume of a later enlarged edition of the original work, embodying the most recent researches, and including the results of confirmatory and independent experiments; and omitting certain generalities and the presentation of such ancillary statements as are desirable in first formulating the basis of a new theory.

The distinguished author is insistent on his theory representing a *phase* of Evolution, neither antagonistic to the theories of Darwin and of those who followed him, nor detachedly critical of them, but complementary and to a certain extent supplementary to them. Darwin contrasted Natural Selection with Artificial Selection. Natural Selection, which formerly occupied such a prominent place in the Darwinian scheme of the survival and salvation of the fittest (a prominence, however, which was neither sanctioned nor encouraged by Darwin himself either in his correspondence or in his later works), is now, by general consent, relegated to the more subordinate position of an agency which is no longer considered causal, but directive.

As Professor de Vries implies, even before the appearance of Darwin's works, it was recognized that the task of systematic biology as a descriptive and classificatory science was different from the mere question of actual kinship. The factor of convenience for the purposes of scientific study had to be introduced as an index to investigation before the required data of morphological facts had been ascertained. At the very moment of the appearance of Darwin's "Origin of Species," the French botanist, Godron, was publishing a work "De l'Espèce et des Races dans les Êtres Organisés." It may be urged that the author's range of biological research is circumscribed in the demonstration and application of his theory. The origin of species is an object of inquiry and of investigation in all three of the biological sciences of Anthropology, Zoology, and Botany. Natural selection is least obvious in the last. Not only is this the section to which Professor de Vries almost exclusively confines his scope of inquiry, but he further restricts it to garden cultures rather than to wild and native plants, in which former category the working of Natural Selection is reduced to a minimum. Where sceptics would like to see the interplay or at least the segregating factors of Mutation-phenomena is in the indigenous flora or, better still, among ethnic types. It is not in accord with the cosmic process of Evolution that diverse results of similar incentives to variation should co-exist in one or more groups of biological phenomena, or in one more obviously than in the others.

The subject is boldly handled in the section on "Systematic Biology and the Theory of Mutation" (page 567). The author essays to clinch the argument by a challenge, that if it can be shown that the mutation theory satisfies the demands of systematic science on the one hand, and of embryology on the other, better than the present form of the theory of selection, its justification as a theory of the nature of inheritance will, in his opinion, be placed on a sure foundation. With the enthusiasm born of empirical theory and of experimental investigation, and with a wealth of illustration, he proceeds to demonstrate the applicability of the theory of mutation to the main conclusions of the doctrine of Evolution, that blessed word which the late Lord Salisbury compared with "Mesopotamia" as a comforting sedative for the minds of jaded theorists.

Here, however, there is some special pleading, and much is made of the experience of gardeners and of interfering hybridists. But, however much Inorganic Nature may abhor a vacuum, it can hardly be said that Organic Nature abhors hybridity. It, in fact, rather presents the opposite extreme, cleistogamy; and does its best to thwart it. Further than this, the hybrid-products familiar as the Common Lime and the Common Elm are more vigorous than their original pairs of parents. On the other hand, the normal fertility of *Salix*-hybrids, and those of *Mentha* and *Rubus*, and of garden-hybrids in Primulaceae, is a well-established fact.

In his concluding pages, the author comments on the geological periods of mutation. Quoting from Lord Kelvin, W. K. Brooks and Professor K. E. Schneider, he agrees with those who assume that in cosmic history there have been special periods of great variability; for instance, "when land-animals, and again when Man, originated." In these periodical waves of rapid and intensive variation unusually active within a definite time, the author, if he accepts the principle of such modes of origin, comes dangerously near an attempted revival of Cuvier's cataclysmal theory, long ago exploded and relegated to oblivion. The writer of this notice humbly ventures to dissent from the *dictum* that this is a question of comparative anatomy and of systematic science. It *was* a question among the more rampant teleologists of the pre-Darwinian days, but it was one which has been convincingly and finally answered.

However much one may dissent from the wide and comprehensive application and the enlarged scope of the theories of Mendelian heredity and of mutational variation in contrast with the original and restricted claims of those who defined them, one cannot but welcome this bold presentation of an attractive theory, which Professor De Vries supports and fortifies with the aid of a laborious, co-ordinating, and instructive series of experimental investigations, and which will strongly appeal to all serious students of Biology,—both those who endeavour to absorb and assimilate all the new light which may be shed on the problems of Evolution, and those who are perplexed with the apparently conflicting and discordant "biochronic equations" which occupy such a subordinate place in their correlation.

FREDERIC N. WILLIAMS.

GEOGRAPHY.

New Zealand.—By THE HON. SIR ROBERT STOUT, K.C.M.G., LL.D., and J. LOGAN STOUT, LL.B. The Cambridge Manuals of Science and Literature. 185 pages. 20 illustrations. 6½-in. × 4¾-in.

(Cambridge University Press. Price 1/- net.)

This little book forms one of the Cambridge Science and Literature Series; in our opinion its contents are neither the one nor the other, and we do not quite see for whom the book has been written. True, a great deal of information is stored in its hundred and eighty-five pages, and the names of its distinguished authors are a sufficient guarantee of accuracy, but further than this we cannot commend the book. We should certainly hesitate to place it in the hands of a schoolboy. As a book of reference, or as a guide to New Zealand, it does not seem to be sufficiently detailed, while as an introduction to the study of the country, its produce and people, it fails to stimulate curiosity or interest.

Modern geography teaching consists not merely of the stringing together of facts, to be committed to memory by the pupil, but it tries to answer the question "Why," and after presenting certain principles, shows as far as possible how these may be brought to explain not only the physical but the political geography of a country as well. We look in vain for any such guiding plan in the volume under review. We hold that a crowd of facts with little or no explanation is useless from an educational point of view, and that the facts themselves, even if retained in the memory, are not likely to be of much value to the general reader. The book, however, would probably be of service for the answering of examination questions of a certain type.

The illustrations taken from photographs are fairly successful, the one of Lake Ada being perhaps the best; but surely a good map would have been a more useful frontispiece than a specimen of Maori carving!

M. D. H.

Textbook of Geography. By G. C. FRY, M.Sc. 2nd Edition. 468 pages. 96 Figures. 5-in. × 7-in.

(University Tutorial Press. Price 4/6.)

In the second edition of this useful textbook a large number of maps and diagrams have been added. The statistical information is brought up-to-date, and an appendix containing numerous examination questions is supplied. These certainly add to the utility of this compact and comprehensive textbook. Whilst the illustrations are in general good and clear, some of the coloured maps are not very successful, notably Figure 76. The book is intended for matriculation students, and is extremely well written and arranged.

G. W. T.

GEOLOGY.

The Changeful Earth.—By G. A. J. COLE, M.R.I.A., F.G.S. 223 pages. 51 Figures. 4½-in. × 7-in.

(Macmillan & Co. Price 1/6 net.)

This fascinating little book is one of a series of "Readable Books in Natural Knowledge," which is intended to stimulate interest in scientific studies, and "to present natural phenomena and laws broadly and attractively." That the book under review fulfils this object goes almost without saying. Prof. Cole has written in his most attractive style the romantic story of geology as it is recorded in the lives and labours of its great pioneers. The history of the changeful earth is told in a series of chapters which describe the achievements of the pioneers in each branch of the science. The reader is gently led up to the present position of geology by a consideration of the development of the fundamental conceptions of the science in the minds of its earlier exponents. In the capable hands of the author this method of presentation is most successful, and we have read few books which are so likely as this to produce a lasting and fruitful enthusiasm for geology. The book is written in a simple and charming style, and makes its appeal as literature quite as much as by its interesting subject matter. As an introduction to geology for nature-students it will be found invaluable.

G. W. T.

ORNITHOLOGY.

The Home-life of the Osprey.—Photographed and described. By CLINTON G. ABBOTT, B.A. 54 pages. 32 plates. 10¼-in. × 7½-in.

(Witherby & Co. Price 6/- net.)

The observations and photographs contained in this work were made in the Eastern States of America, and Mr. Abbott, knowing that the Osprey is all but extinct in Britain, and that any nests existing in recent years were in solitary and remote places in the Scottish Highlands, remarks on the surprise with which he saw his first American Osprey's nest. "It was," he writes, "at a popular seaside resort in New Jersey, and perched on a tree over a lake full of row-boats and noisy holiday-makers" (page 7). The bird probably still nests, or attempts to do so, within the bounds of the city of New York, and on Gardiner's Island about three miles from Long Island (where the species has been protected for many years), it is estimated that some two hundred nests are in existence. Mr. Abbott has put his opportunities on this island and elsewhere to excellent use, and has given us a series of valuable personal observations on the fishing, breeding and other habits of the Osprey, and on the rearing and conduct of young birds in the nest. He gives an instructive narrative of a continuous twenty-five hours watch with his camera close to a nest with young, the object being to ascertain some definite data as to how often young Ospreys are fed. During this watch food was only brought to the nest three times, and Mr. Abbott thinks that the young are not fed more than twice, or at the most, three times a day; this infrequency surprises him, and he asks for further information.

The numerous photographs by Mr. Abbott and Mr. H. H. Cleaves accompanying the work are very fine indeed, and it is not too much to say that by themselves they tell the story of the bird. Some particulars are given of the photographic methods adopted in securing these pictures and the enthusiastic pleasure which Mr. Abbott expresses in this work is well justified.

H. B. W.

Report on the Immigrations of Summer Residents in the Spring of 1910. Also Notes on the Migratory Movements during the Autumn of 1909. By the COMMITTEE APPOINTED BY THE BRITISH ORNITHOLOGISTS' CLUB. 314 pages. 21 maps. 8½-in. × 5½-in.

(Witherby & Co. Price 6/- net.)

This is the sixth annual consecutive Report of the valuable and important work being done by the Migration Committee of the B.O.C., and they explain that the lines followed are similar to those of previous Reports. A great amount of information is given, but no remarkable phenomena or abnormal movements seem to have occurred during the period reported on, and the records are almost entirely similar to those of previous Reports and, of their kind, well known to observers and students. The accumulation of facts on a uniform system over a series of years is of essential importance in such researches, but it may reach a point at which it ceases to be information. For instance, it seems superfluous, and in no way an addition to our knowledge, to give in detail the ordinary dates of the arrivals of common summer bird-visitants, and these might be taken for granted, and only departures from the normal chronicled. Both the Editor and the Committee remark on the voluminous character of the Report and their endeavours to condense it. The attainment of this end would be assisted by their publishing only observations and returns of material importance throwing fresh light on the subject or containing new records. The space thus made available might be utilized in extending the field of the enquiry and amplifying its usefulness. A real advance might be attempted in co-opting and co-ordinating observations made by others, a task which the influence and learning of the B.O.C. make more likely of attainment by them than otherwise. The limited character of the Report as now compiled is shown in one direction by the records given of a few of the scheduled birds from the Clyde district (thus extending the work beyond England and Wales), while records of other birds in that district are ignored, as well as the whole of the information published elsewhere for other parts of Scotland.

The immigrants reported on in detail in the volume are thirty-three in number, and twenty-one of them are also separately mapped, a graphic and useful assistance. The "unscheduled birds" (pages 160-181) and those dealt with in the "Notes on the Migratory Movements during the autumn of 1909" (pages 200-260) are somewhat hidden, by not being named in the table of contents (there is no index), but there are some excellent short accounts of bird-movements under these headings. The reports on the Starling (pages 167 and 233) and the Crossbill (page 231) may be specially mentioned. Under the last-named the apposite remark is made that "if the true cause of these sporadic irruptions of certain species were known we might have a clue to the beginnings of the migratory instinct." Might this conjecture not be extended to include the sporadic movements of any species?

H. B. W.

TIDES.

The Tides and Kindred Phenomena of the Solar System. By SIR G. H. DARWIN, K.C.B., F.R.S. Third edition. 1911. 437 pages. 46 illustrations. 8-in. × 5·5-in.

(John Murray. Price 7/6 net.)

Successive editions of a book afford some test of the general need or approval for the work; it proves that the

[illegible]

[illegible] the earth and ocean.

[illegible] new edition of this [illegible], and [illegible] in the author's own words, "Even [illegible] the author had written the [illegible] for the first edition in 1897, though not published [illegible] October, 1898, the aspect of some parts of my subject had already changed considerably, so that in 1902 some alterations had become necessary, and now, after a further lapse of eight years, yet more extensive revision is needed. It is scarcely possible to revise an old book so as to make it into a new one, and it is not, perhaps, desirable to attempt to do so, because there is a certain interest in observing the gradual development of scientific thought. It seemed to me, therefore, that the best way of incorporating into this volume the recent advances of science was to add supplements to the several chapters, and only to make minor alterations in the original text."

[illegible] Chapter XX in the first [illegible] of Liquid [illegible] XIX, Speculations [illegible] Origin of Double Stars [illegible] XX, and the [illegible] of Colliding Systems, [illegible] XXI; the last three chapters being [illegible].

We notice an error in the chapter on Saturn's Rings at the foot of page 336. The discovery of the inner dark, or crape, ring is credited to Bond and Dawes as having been made in 1850, though these two eminent observers undoubtedly saw [illegible] independently for the first time, the credit of placing the discovery definitely on record should have been given to Dr. J. G. Galle, who had made a series of observations of the dark ring in 1838. These were published a few months later.

Not the least valuable portions are the numerous references to the works of those upon which the book is based, and the index—the part of a book often scamped. A few other later references might have been added with advantage to some of the chapters.

The first edition had three hundred and thirty-four pages of text in twenty chapters, and eight pages for the index, with forty-three illustrations; the third edition is expanded to four hundred and twenty-six pages in twenty-one chapters, and ten-and-a-half pages of index, with forty-eight illustrations. Besides the three editions published in England, two have been published in U.S.A., two in Germany, one in Hungary, and one in Italy. Altogether, a practical book of great interest, well arranged and printed, and at a moderate cost.

SOLAR DISTURBANCES DURING NOVEMBER, 1911.

By FRANK C. DENNETT.

The Sun has shown more activity so far as spots were concerned, but there has been a marked decrease in the amount of faculic disturbance. Of the twenty-eight days on which observations were possible the disc presented an apparently clear unruffled surface on nine, namely the 7th, 8th, 11th, 14th, and 16th until 20th, whilst only a little faculic disturbance was visible on the 5th and 6th nearing the western limb. The longitude of the central meridian at noon on November 1st was 240° 48'.

No. 38. This group, consisting of one small spot as leader, possessing three umbrae, and followed by eight pores, broke out suddenly on November 1st. Its length was 58,000 miles. On the 2nd only the spot was seen at the western end of a coarsely granulated area; it dwindled on the 3rd and 4th, when last seen, the area being marked during the next two days by the above-mentioned faculic disturbance.

No. 39. On the 9th and 10th the position of this little pore was carefully measured. On the 11th nothing was seen, but on 12th and 13th in the same area, or very near to it, one and two tiny pores respectively were seen, but their exact positions could not be determined owing to the combined difficulties of minute size and rapidly travelling cloudiness.

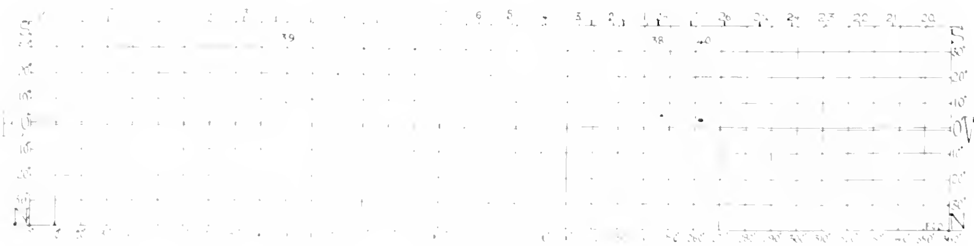
No. 40. A fine spot was seen to have come round the limb on the 21st, rimmed on the western side by faculae. There were two umbrae, and when last seen on the 29th the inner edge of the penumbra was bright edged. Its diameter was 14,000 miles. There was a pore a little south-east on the 24th.

Within the eastern limb on the 28th there was a small faculic disturbance.

Not only is there a falling off in activity when the Sun is examined with the telescope alone, but there is a similar decrease in the number of prominences and other phenomena shown with the spectroscope.

Our chart is constructed from the joint observations of Messrs. John McHarg, F. E. Peacock, and F. C. Dennett. The wide distribution of the observing stations at Lisburn, Bath, and Hackney proves very helpful in preserving the continuity of the record.

DAY OF NOVEMBER, 1911.



NOTES.

ASTRONOMY

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

I begin my notes by expressing my sense of the loss that Astronomy has sustained in the death of Mr. W. T. Lynn. His name has become well-known throughout the astronomical world for his laborious researches connected with the biographies of astronomers and the clearing up of obscure points in astronomical history. His little books on Comets and Eclipses did much to spread a knowledge on these points, and their popularity is shown by the frequent new editions that were called for. His birth appropriately coincided with the appearance of Halley's Comet in 1835, so that his life was practically coeval with a revolution of the comet.

He worked to the last, having read a paper before the British Astronomical Association in November, and contributed letters to the recent and forthcoming numbers of the *Observatory*.

ARE THE WHITE NEBULAE GALAXIES.—If one opens an astronomical text book of some sixty years ago one will probably find it supporting the view that the nebulae as a whole are external Galaxies. When the spectroscope revealed the gaseous nature of many of them this view was generally abandoned, and it was supposed that all the nebulae were within our Galaxy. Mr. R. A. Proctor strongly supported the latter hypothesis, arguing that as we cannot resolve all parts of our own Galaxy it is extremely unlikely that we can see external ones. He seems to have overlooked the consideration that bodies which have sensible discs do not lose in surface brightness, but only in size, when the distance is increased (assuming that no light is absorbed in traversing space).

The ancient view is now being revived in many quarters, as far as the white nebulae (those with a continuous spectrum) are concerned. Sir David Gill recently advocated it in a lecture delivered before the Royal Institution, and *Astr. Nachrichten*, No. 4536, contains an article on the same subject by Professor F. W. Very. He takes the great Andromeda nebula as his standard; its longer axis (neglecting faint outlines) is 110′. He calls the distance of this nebula one "Andromede," and endeavours to find it on the following two suppositions: (1) that its real diameter is equal to that of our Galaxy, its distance is sixty Galactic radii; (2) assuming that Nova Andromedae belonged to the nebula, and that its intrinsic brightness at maximum was equal to that of a Galactic star of zero magnitude, its distance is twenty-five Galactic radii. On the latter assumption it is much smaller than our Galaxy. Professor Very takes the mass of the Galaxy as equal to twenty million suns, and deduces that of the nebula as one and a quarter million suns.

He takes the distance of our Galaxy as some sixty light years, which appears to be too small, seeing that according to this value the Galactic stars should have large proper motions, and these in reality are very small. On this basis, and adopting the value twenty-five for the ratio of distances, he takes the distance of the Andromeda nebula as one thousand six hundred light-years. The smallest of the white nebulae have diameters about one six-hundredth of that of the Andromeda nebulae, whence their distance would be a million light years. He finds some evidence for the absorption of light in space from the fact that the smaller nebulae appear also to be intrinsically fainter (surface for surface). He takes the transmission factor [illegible] Andromeda [illegible] [illegible] the Andromede, it would be [illegible] 182, or only one [illegible] [illegible].

Still another [illegible] of the fact that the Galactic stars are on the whole beyond the [illegible] of sensible proper motions has been [illegible] by Mr. Bellamy in *Monthly Notices* for November. He has examined the larger proper motions of stars in the zone between 24° and 26° North Declination, from pairs of plates taken at an interval of some ten years, with the following results:

FIGURE 39.

Mars, 1911.
October 11th.
λ 70°.

Mean Galactic Latitude	Mean No. of Stars per Plate		Mean No. of P.M.s per Plate
4° [illegible]	615	...	5·9
21	347	...	5·7
37	158	...	4·6
55 [illegible]	85	...	5·1
78	74	...	4·8

Only proper motions exceeding one-tenth of a second per annum are included. It will be seen that while there is a slight increase in the number of proper motions near the Galaxy, it is not at all in proportion to the increase in the number of stars, showing that the Galactic stars lie beyond the region of easily detected motions. Professor Very is conscious of the difficulty, but endeavours to evade it by suggesting that the absolute velocities of stars in the Galactic system are smaller than in the Sun's neighbourhood, on the analogy of the diminution of planetary velocities as their distance from the sun increases; but it is to be noted that even if we grant this as regards their absolute motion, the motion of the solar system would still give them a large apparent motion. It is fairly well established that the sun moves through some four astronomical units per annum, which, if unforeshortened, would give a star at sixty light-years distance an apparent motion of one-fifth of a second per annum; the Galactic stars certainly show no motion approaching this amount, whence it appears certain to me that the Galaxy is far more than sixty light years distant, so that all Professor Very's estimates of Nebular distances would need multiplication by a considerable factor.

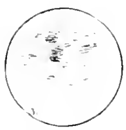


FIGURE 40.

Mars, 1911.
November 14th.
λ 55°.

It is, of course, by no means certain that, even if the white nebulae are composed of stars, they are external Galaxies; they may well be miniatures of the Galaxy included within its limits. The fact that these nebulae as a whole shun the Galactic Circle, and are somewhat clustered about its Poles, presents a considerable difficulty to the theory of their being external.

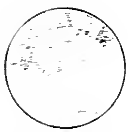


FIGURE 41.

Mars, 1911.
November 14th.
λ 94°.

Sketches made at Flagstaff.

NOTE.—The [illegible] marked H [illegible] the approximate [illegible].

PHOTOGRAPHS OF MARS.—Professor Lowell has sent me three plates, each containing twenty exposures of Mars. The first was taken on October 11th by Mr. Slipher (longitude of centre of disc 70°). It shows Aurorae Sinus, Lacus Solis, Tithonius Lacus, Argyre, and traces of several canals. The pair of plates taken on November 14th (longitudes 55° and 94° respectively) show the same general region of the planet (see Figures 40 and 41); their special interest lies in the white patch at the bottom of the disc, to the right of the polar cap, which Professor Lowell considers to be morning hoar-frost; comparison of the two pictures shows that it does not move on with the surface details, but clings to the morning limb, and this certainly supports the hoar-frost theory. The plates bring out much variety in the depth of shading of the Maria, and show some indication of the canals across these; the sketches given here [illegible] indicate the principal detail [illegible] on the plate. A [illegible] Journal of the Astronomical Society [illegible] reproduction of a beautiful photograph of M[illegible] Professor Barnard at Yerkes in [illegible] with the great reflector at Mt. Wilson [illegible] successful in showing the various [illegible] broke down in fine detail; a refractor [illegible] this respect. We have reached [illegible] to be a real aid in our study of the great [illegible]

ENCKE'S COMET.—The reason of the large discordance between prediction and observation in the positions of Encke's comet last summer has been detected. Through an unfortunate erratum the ephemeris was computed from elements in which the eccentric angle was 10′ too small. A corrected ephemeris has now been formed, and Professor Backlund gives in *Astr. Nachrichten*, No. 4539, a comparison with the observations. The values of observed minus computed quantities are as follows:—

Place	Date 1911	Observed R.A.	Computed Dec.	No. of Nights
Algiers ...	... July 31 ...	$1^{s}\cdot58$ ...	+ 8″·3 ...	1
Cape ...	... Sept. 6 ...	$+0^{s}\cdot14$ ...	+ 4″·6 ...	8
Johannesburg ...	Sept. 9 ...	$+0^{s}\cdot03$ ...	4″·8 ...	11
Santiago,Chili ...	Sept. 24 ...	$+1^{s}\cdot41$ ...	26″·3 ...	1

It is clear from these figures that the predicted date of perihelion is very nearly right, and Dr. Backlund concludes that his value of the mass of Mercury 1/9,700,000 is confirmed, and that the acceleration of the mean motion of the comet suffered a notable diminution about the time of perihelion in 1904.

SCHAUMASSE'S COMET.—The eighth cometary discovery of 1911 was made on November 30th, by M. Schaumasse, an assistant at the Nice Observatory. It was only of the twelfth magnitude but will probably be of at least the tenth in January. The elements are:

T 1912, Feb. 5·35, G.M.T.
ω = 100° 8′
Ω 115° 12′
i 20° 20′
q 1·170

Position on January 1st, R.A. $15^{h}\ 17^{m}\ 52^{s}$, S. Dec. 1° 47′, daily motion + 4^{min}, South 15′. It is a morning star, rising some 5^{h} before the Sun.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

STRUCTURE OF CLOSTERIUM.—Two interesting papers have recently been published on the structure of this beautiful genus of Desmids, by Lutman (*Bot. Gaz.*, April, 1910 and June, 1911). *Closterium* is a large genus (with about sixty British species, for instance), and is easily recognised by its elongated cell, which is usually curved and often markedly semilunar in form, tapering at each end to a pointed tip or pole. At each pole, there is a vacuole containing minute particles of calcium sulphate, suspended in liquid and showing vibratory movement: *Closterium* is also interesting as showing active streaming movements of the protoplasmic layer within the cell wall.

In his first paper, Lutman shows that the descriptions hitherto given of the structure of the chromatophore or chloroplast are inaccurate. His methods of sectioning the plants with the microtome show that each of the two chromatophores consists of a hollow cone bearing relatively narrow longitudinal ridges on its outer surface; the number of these ridges is greater than has been previously described, and they may be as many as eighteen and rarely fewer than twelve. Apparently it is practically impossible to count the number of the ridges accurately except in sections. All previous writers on this Desmid have described the chromatophore as consisting of a solid longitudinal axile rod bearing a number of radiating plates. Lutman shows, however, that this is not the case, and that in cross section the chromatophore does not resemble a hub with radiating spokes, but is more like a coarsely cogged wheel. The protoplasm in the furrows between the ridges of the chromatophore is frequently much denser in structure than the chromatophore itself, but contains numerous vacuoles of varying sizes; however, there are great differences in this respect, and sometimes this protoplasm is reduced to a mere network occupied almost entirely by vacuoles. The external appearance of the plant is determined largely by the density of the protoplasm between the ridges; sometimes the plants are so dark green as to be almost opaque, at other times much lighter green and semi-transparent.

Lutman then describes the pyrenoids in the two species of *Closterium* studied by him; in *C. ehrenbergii* they are embedded in the outer portion of the chromatophore, while in *C. moniliferum* they are situated exactly at its centre and are arranged in a single row along the central axis of the cell. In addition to the layer of starch which encloses each pyrenoid there are numerous starch grains lying free in the protoplasm, usually in longitudinal rows along the ridges of the chromatophore. The free starch grains exactly resemble the pyrenoid ones, being angular at the edges and concave and clearly originated around a pyrenoid. It is difficult to say whether these free starch grains became free by a second layer of starch being formed around the pyrenoid and crowding out the old layer, or by the breaking-up of the pyrenoids themselves. In size the pyrenoids vary from bodies almost impossible to see with the highest magnification to spheres whose diameter is one-fifteenth that of the *Closterium* body itself. The starch is present as a layer of irregularly-shaped grains, but sometimes more than one layer is suggested by the appearance of other grains just outside the regular layer. No two pyrenoids are alike as to the shape of the grains around them; there is no stratification visible in either grains or pyrenoids. Where strands of protoplasm run across the central part of the cell body, they tend to be oriented on the pyrenoids, exactly as in *Spirogyra*, and so on; this arrangement, which is doubtless connected with the streaming movements of the protoplasm, puts the pyrenoid in quick communication with all parts of the cell, and facilitates the movement of food materials toward and away from it. The pyrenoids may be angular or rounded; they often contain denser and lighter portions, and sometimes a vacuole; they often divide up into a number of discs or segments of varying number and form. If plants are kept in darkness for a few days, the starch around the pyrenoids rapidly disappears, while the pyrenoids themselves are found to have diminished one-third to one-fourth in size, showing that some of the pyrenoid substance has been used up.

In his second paper, Lutman deals with the structure and division of the nucleus in *Closterium*. The nucleus lies at the central and thickest part of the cell, between the two chromatophores, and has the form of a double convex lens. It consists of a fine network of lightly-staining fibres, with a mass of deeply-staining granules in the centre. The first external sign of division is a pinching-in of each of the two chromatophores, at about a third of the distance from middle to tip of the cell, as if it were being constricted by a rubber band around it at each of these two places. The chromatophore, in fact, seems to divide in the way the entire cell divides in animals like *Amoeba*. Meanwhile, the nucleus proceeds to divide, and after the chromosomes have been drawn to the two poles, and across the middle of the cell, there now appears a broad granular band in which the new cell-wall is formed. The two new nuclei then pass along, within the cell-wall, to the new position they are to occupy permanently in the new cell at the middle of each chromataphore. Soon after the new cross-wall is put in at the middle of the Desmid, the new end begins to round out, but the two individuals hang together for quite a time with only a slight connection, which finally breaks, the individuals separating before the new halves are at all symmetrical with the old ones.

Lutman deals with the apparently unequal division of the chromatophore. A *Closterium* plant is, apart from its curvature, composed of two cones placed base to base, and when the chromatophore in each half divides, by a plane parallel to the base of the cone, we get a cone and a frustum formed, the cone being longer than the frustum and apparently much larger. On determining the *volumes* of these two portions, however, the surprising fact is revealed that the cone has not more than two-thirds the cubic contents of the frustum. However, the blunt (frustum) portion includes half of the large nucleus of the plant and of the large vacuoles around the nucleus, which do not appear in the cone end. This blunt end is the one which has to undergo reconstruction, a process requiring the using up of a good deal of material like starch, of which this portion contains more than the cone. Hence this new half cannot be said to "grow out" in the sense of having to grow in order to become as large as the pointed end, since it contains quite as much material as the old end. There is a re-shaping of this material, but both ends take part in the growth that is to produce again a normal size in the individual.

The division process in the two species of ***Closterium*** examined by Lutman occurs at night time, and takes two nights for its completion. The chromatophore divides the first night; while on the second night the nucleus divides, between 10 p.m. and 5 a.m., the new half becoming practically symmetrical with the old one by 9 a.m. *Closterium* as seen in the daytime has its chromatophore divided into halves, resulting from the chromatophore division of the preceding night, and the two halves are also to be regarded as a preparation for the division of the nucleus and cell the following night providing it has succeeded in storing enough food material to make the process possible.

Leaving aside some interesting points in reference to nuclear division, especially the relations between the central mass (nucleolus) of the nucleus and the formation of the chromosomes, Lutman's observations clear up various questions regarding the structure and affinities of the Desmids. In ***Closterium*** itself, for instance, the method of origin of the two daughter chromatophores by constriction explains the fact that the ridges of the chromatophore on each side of the nucleus correspond. The continuity of the outer granular layer of protoplasm, in which the streaming occurs, is explained by the fact that the constriction of the dividing chromatophore is due to a ring-like vacuole formed within this granular layer, which is, therefore, not divided but is left intact and enables active streaming to take place between the two halves of the cell.

Again, the process of cell division supports the view that the Desmids have arisen from filamentous Algae. The new cross-wall grows inwards as a widening ring from the peripheral cell-wall, in exactly the same way as in *Spirogyra*, and it is only as the two new cells separate and the pressure is relieved on one side of this wall that its shape changes. If the cells did not separate, a filament being formed, each cell of the filament would be essentially like a cell of *Zygnema* with its nucleus at the middle, and a half of the symmetrical chromatophore on either side. The pointed shape which the new end assumes is clearly a secondary character, and we may assume that *Closterium* (and, therefore, the Desmids as a whole) arose from filamentous forms, which developed the habit of breaking up into single cells.

The great majority of the Desmids are unicellular, but a tendency to form filaments is seen in various genera, as ***Cosmarium, Euastrum, Staurastrum.*** The view that the Desmids have arisen from filamentous forms, and are what may be called a degenerate group, explains various points in their structure and biology, *e.g.*, the highly-specialised external characters of the cell and cell-wall, and the loss of sexual differentiation of the conjugating cells.

CHEMISTRY.

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

INTERNATIONAL ATOMIC WEIGHTS FOR 1912. The Committee of International Atomic Weights has issued its report and table of atomic weights to be used in the coming year. The list now numbers eighty-two elements, having been increased by the addition of niton, the name given to the emanation of radium. This substance is a gas belonging to the argon group. Its atomic weight, determined by means of a micro-balance, was calculated to be 223, but from other considerations the value 222·4 is regarded as the more probable and is the one given in the table.

Determinations made during the past year have resulted in trifling alterations being made in the values of calcium, erbium, iron, tantalum and vanadium, while the experiments of Easley (*J. Amer. Chem. Soc.* 1910, XXXII, 1117) have caused the committee to change the atomic weight of mercury from 200·0 to 200·6. This is the most important alteration in the table. As in the case of the last few years the whole of the values are compared with oxygen as 16, and hydrogen as 1·008, and the alternative values based upon hydrogen as unity are no longer published.

MARINE FIBRE. A new textile fibre has recently been put upon the market under the name of "Marine Fibre," and is sold at about £5 per ton. It is derived from the bottom of Spence Bay in South Australia, and notwithstanding the fact that it is soft and not very strong, it may be spun in admixture with wool and other fibres. It differs from sea weed in structure and composition, and appears to have originated from some land plant, such as New Zealand flax. An account of its chemical characteristics is given by Messrs. Green and Frank (*Journ. Soc. Dyers and Colourists*, 1911, XXVII, 160), who point out that the high proportion of salt which it contains renders it almost non-inflammable. It may be easily dyed with basic dyestuffs, in which respect it resembles jute, but it has little affinity for acid dyestuffs or sulphur dyes.

STERILISATION OF WATER BY ULTRA-VIOLET RAYS. The use of the ultra violet rays for the sterilisation of water is now in general use, and various types of apparatus have been patented. Among the most recent of these is the apparatus of Henri Helbronner and von Recklinhausen of Paris (Eng. Pat. 4895, of 1911), in which a mercury vapour lamp enclosed in a quartz chamber is immersed in the water, while a ball-float or similar device prevents the action of the lamp taking place until the liquid has arisen above the level of the quartz chamber.

A main essential for effective sterilisation is that the liquid shall be relatively transparent to the radiation, since liquids containing colloidal bodies (gelatine, peptones, and so on), absorb the rays, with the result that only the immediate surface becomes sterilised. For this reason, as has been shown by Rolle, (*Woch. Brau.*, 1911, XXVIII, 533) the process cannot be used for the sterilisation of malt liquors.

In the case of clear water, however, the sterilisation is so rapid that a simple apparatus has been devised by Rogier to be attached to a water tap. This consists essentially of a cylindrical mercury vapour lamp in a quartz chamber, which is surrounded by an aluminium tube narrowing at one end, so that the water comes close to the lamp on its way. It will give a yield of two hundred to three hundred gallons of sterile water per hour.

The large plant installed at Marseilles for the sterilisation of the drinking water works at a cost of 1·1d. per thousand gallons, but this cost might be reduced by about half, and would then be cheaper than sterilisation by ozone. According to Courmont (*Chem. Zeit.*, 1911, XXXV, 800) the sterilising process does not depend upon the formation of ozone or hydrogen peroxide.

CARBON MONOXIDE DETECTOR. A simple and effective apparatus, for detecting traces of carbon monoxide in the air has been devised by Dr. Nowicki (*Oesterr. Zeit. Berg.-u. Hüttenw.*, 1911, LIX, 587), and should be found of great use in mines. It consists of a glass vessel, the inlet and outlet of which are provided with stopcocks. The air to be tested is forced through the vessel by means of a rubber bulb, until the air inside the flask has been displaced. The stopcocks are then closed, and a note taken of the time required to blacken a strip of filter paper moistened with palladium [illegible] the [illegible] before applying [illegible] When [illegible] carbon monoxide in excess of 0·1 per cent [illegible] shows signs of darkening within [illegible] as little as 0·01 per cent. [illegible] affect the paper [illegible] seven minutes.

COMPOSITION OF SOME EARLY MATCHES.—A paper has been read before the Chemical Society by Mr. F. G. Clayton (*Proc. Chem. Soc.*, 1911, XXVII, 220) in which are given some interesting particulars of the characteristics and composition of some of the earliest matches put upon the market.

The so-called "Promethean" matches, introduced in the early part of last century by Samuel Jones, consisted of a mixture of potassium chlorate, sulphur and other substances, which was ignited by contact with sulphuric acid, supplied separately in a small glass tube.

Then in 1826-7, the first "friction lights" were invented by John Walker. The main constituents in these were sulphur, antimony sulphide and potassium chlorate, and they were ignited by being drawn between strips of sand paper. Their success led to the manufacture of similar "friction lights" by Samuel Jones (the originator of "Prometheans"), and to these he gave the name of "Jones' lucifers" or "Chlorate matches."

The following analyses show the percentage composition of some of these early matches in use prior to the introduction of phosphorus matches:

Name of Matches.	Sulphur.	Potassium Chlorate.	Lycopodium.	Gum.	Antimony Sulphide.	Ferric Oxide.
"Prometheum"* Matches (1828) ...	24·7	34·0	8·8	31·6		
"Lucifer" Matches I. (1832-3)	6·5	27·6	—	35·7	24·6	5·6
"Lucifer" Matches II. (1832-3)	12·5	41·0	—	24·9	18·1	3·5

* Ignited by dilute sulphuric acid coloured with indigo.

Soon after the introduction of "lucifer" matches, the first phosphorus matches were manufactured. They were sold under the name of "Congreve matches," and were probably so called after Sir William Congreve, who invented the war rocket.

These matches, large quantities of which were made abroad, and especially in Germany and Austria, contained ordinary phosphorus, and also differed from the lucifers in being ignited by being "struck upon the box." The composition of two kinds of these matches, the first probably representing the earliest phosphorus matches sold in England, is shown in the following examples taken from Mr. Clayton's long table:

Phosphorus Matches.	Ordinary Phosphorus.	Sulphur.	Potassium Chlorate.	Chalk.	Dextrin.	Gum.	Dye.
German ... ... (about 1835)	20·5	14·3	32·1	8·0	25·1	—	[illegible]
Austrian ... (1845-1850)	17·8	11·5	37·4			33·3	

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

PLIOCENE FLINT IMPLEMENTS.—Momentous discoveries of flint implements have been recently made in East Anglia—one, by Mr. J. Reid Moir, in the detritus-bed at the base of the Red Crag in Suffolk; and another, by Mr. W. G. Clarke, at the base of the Norwich Crag in Norfolk. These sub-crag implements are described by Sir Ray Lankester (Meeting of Royal Society, November 16th) as of a special type which cannot be associated with any yet known from other localities. The type is called the rostro-carinate or "eagle's beak," and includes also scrapers, borers, and large one-sided pieces. The rostro-carinate implements are compressed from side to side, and are thus distinguished from the Chellian and Mousterian types, which are flattened like a leaf. They were manufactured prior to the period of severe glaciation, and are thus older than any previously known on equally good evidence. On account of the affinities of its molluscs Sir R. Lankester is disposed to believe that the Red Crag should be grouped with the Pleistocene rather than the Pliocene. The race of men who made the rostro-carinate implements are believed to have lived near the sea in the time of the Coralline Crag. Some of the implements were washed into the detritus-beds at the base of the East Anglian Crags, but others remained on the land surface, and were subsequently included in glacial sands and boulder-clays, in which a few have now been found. In view of the importance of the announcement, it is to be hoped that indisputable evidence will be forthcoming that the implements really came from the beds named, as there are so many possible sources of error attending the discovery of implements in deposits earlier than the Pleistocene.

ORIGIN OF THE DIAMOND.—The fascinating problem of the genesis of diamonds receives further attention from Dr. O. H. Derby (*Journ. Geol.*, Oct.-Nov., 1911), who puts forward a new speculation as to the origin of the gem. As is well known, diamonds occur, at least in South Africa, in pipes of volcanic origin which are filled with a peculiar ultra-basic rock called "Kimberlite." This rock is invariably much fragmented and altered, and contains numerous foreign inclusions (xenoliths), both of igneous and other origin. The weight of evidence is in favour of the diamonds being assigned to the eruptive rock proper, and not to the xenoliths included in it. Dr. Derby believes that a positive, and perhaps genetic, relation exists between the diamond and the fragmental condition of its matrix, basing his opinion on the experiments of Gardner Williams, who crushed twenty tons of the eclogite boulders or segregations from the Kimberley Mine without finding a single diamond. This association of diamond with fragmentation means that the origin of the diamond is to be assigned to reactions between the rock constituents, made possible by the explosive and disintegrating action of the agency that formed the Kimberley pipes. Under this view the extensive hydration and carbonation of the Kimberley rock is due to deep-seated pneumatolytic action rather than to atmospheric weathering. Kimberlite from the deepest part of the De Beers Mine (2,040 feet), still contains 6·81 per cent. of combined water, and it is improbable that this can be due at that depth to atmospheric weathering. Dr. Derby presents a new hypothesis of the origin of the diamond on the assumption of the deep-seated origin of the alteration of the diamond matrix. He believes that the Kimberlite pipes were saturated with hot (possibly superheated) gases and liquids, and constituted huge crucibles in which carbon would be present at least in the form of carbon dioxide, and probably in other gaseous forms. Thus the material and some of the physical conditions for unusual carbon segregation would be present, and it is possible that, under these conditions, diamonds would be formed. The suggestion is made that the rôle of carbon in eruptive phenomena generally would be an attractive subject for experimental researches such as could be carried on in the Geophysical Laboratory of the Carnegie Institute at Washington.

GLACIATION OF NORTH ARRAN.—The sculpture of the mountains of Arran, the most beautiful of the Clyde islands, has recently been studied in detail by Mr. F. Mort (*Scottish Geog. Mag.*, Dec., 1911). These mountains consist of a mass of granite with a nearly circular outcrop; and whilst never reaching three thousand feet in height, constitute some of the finest mountain scenery in Great Britain, in consequence of their sharp spiry summits, serrated outlines, deep valleys, and great precipices. This remark applies particularly to the eastern mountains grouped about Goatfell. To the west the forms become soft, rounded, and full-bodied, the altitude sinking to less than two thousand feet. This contrast is due to the fact that the western hills owe their smooth outlines to the work of the great ice-sheet which once covered the island, whilst the higher Goatfell group became subsequently a centre of independent glaciation. Its originally smooth outlines have consequently been destroyed, the rounded ridges have been narrowed into gashed and serrated arêtes, great corries or cirques have been gouged out of the mountain sides as if by a gigantic cheese-scoop; whilst deep U-shaped valleys have been carved, in which the existing streamlets appear as almost ludicrous "misfits," and whose tributaries form beautiful hanging-valleys.

The Arran mountains rise from a well-marked plateau at a level of one thousand feet above the sea. This plateau is built of such diverse rocks as Schist, Old Red Sandstone, Triassic, and Granite, and has a most immature drainage, presenting an example of extremely youthful topography. This is taken as proof of its recent origin. It is believed to represent the remains of a peneplain of marine denudation, and doubtless belongs to the one thousand foot platform so well developed in the adjacent Grampian Highlands.

Mr. Mort reaches the same conclusion in regard to Arran as does Professor W. M. Davis in regard to the Snowdon group, namely, "that a large-featured, round-shouldered, full-bodied mountain of pre-glacial time has been converted by erosion during the Glacial Period—and chiefly by glacial erosion—into the sharp-featured, hollow-chested, narrow-spurred mountain of to-day."

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended November 18th, as set out in the Weekly Weather Report issued by the Meteorological Office, was mostly dull and unsettled. Over a large portion of the kingdom rain was experienced daily, some of the amounts being very large. Sleet or snow were common in the N. and E. of Scotland late in the week. Aurora was observed in Scotland on the 16th, and thunder was heard in Ireland on the 17th.

Temperature was above the average in all districts except Scotland, N., the excess reaching 4°·6 in England E. The highest readings reported were 60° at Hillington and 59° at Hereford. The lowest readings were 24° at Baltasound, 25° at Nairn, and 26° at Kilmarnock. In Ireland the minimum was 35°, and in the English Channel 43°. On the grass readings down to 20° (at Llangammarch) were observed.

Rainfall was in excess very generally, and was more than double the average in many places. At Tunbridge Wells the total for the week was 2·67-ins., as compared with an average of 0·78-ins. Bright sunshine was in defect in all districts except Ireland N., where it was normal, and in the English Channel, where it was just above.

The mean temperature of the sea-water ranged from 41°·0 at Kirkwall to 52°·9 at Newquay.

The week ended November 25th was cold generally, the defect as compared with average reaching 5°·0 in Ireland S. The highest reading was 53° at Guernsey on the 20th, but at a number of stations the maximum did not exceed 45°. The lowest readings were 21° at Balmoral and 22° at Birr Castle. On the grass very low readings, down to 10° (at Llangammarch), were noted. Rainfall was in excess of the average in Scotland E. and England N.E., but was in defect elsewhere. In Scotland W. the week was almost rainless, the district value being only 0·02 inches, as compared with an average of 1·19 inches. Sunshine was in excess in the Western districts, but was in defect in the English Channel and was about normal elsewhere. Valencia reported the largest aggregate, 33·2 hours (57%), while at Westminster the total was only 2·2 hours (4%).

The average temperature of the sea water ranged from 4[illegible]·4 at Kirkwall to 51°·5 at Newquay.

During the week ended December 2nd, the weather over the United Kingdom was changeable, but not very wet. Snow and sleet were experienced in the North and East, and thunder was heard at Kilmarnock on December 1st.

Temperature did not differ greatly from the normal. It was a little above the average in Scotland, England, N.W., and Ireland, N.; in other districts below it. The highest reading was 56°, reported from Glencarron, Hawarden Bridge and Markree Castle. The lowest readings were 20° at Nairn, and 21° at Strathpeffer. Frost was observed in every district except the English Channel, where the minimum was 34°. The lowest reading on the grass was 17° at Llangammarch.

Rainfall was below the average in all districts except England N.E. In England S.E. and the English Channel it was but little more than half the usual amount. There were no stations without rain, and at several places rain was measured on each day. Sunshine was scanty; the sunniest district was England S.W., with 17 hours (30%), but England E. had only 4 hours (8%). The sunniest station was Newquay with 22·3 hours (39%). Westminster reported 1·8 hours (3%).

The mean temperature of the sea water varied from 40°·0 at Kirkwall to 48°·3 at Scilly and at Plymouth.

The week ended December 9th was very unsettled, but with bright intervals. Snow and sleet were experienced in some Northern districts, and thunder accompanied by hail occurred at Westbourne on the 6th.

Temperature was below the average very generally, the greatest deficiency being in Ireland S. The highest readings were 57° at Pembroke, and 55° at Cambridge and Dumfries, on the 3rd. The lowest of the minima was 21° at Balmoral on the 8th. The English Channel was again the only district which was free from frost in the air, although at Guernsey there was a reading of 27° on the grass. The lowest reading on the grass for the week was 12° at Llangammarch Wells.

Rainfall was in excess in all districts except Scotland N. In England S.E. and S.W. and in Ireland S. the totals were more than double the average, and at many stations rain was measured on each day of the week. In spite, however, of the frequent and heavy rains sunshine was considerably above the normal in all districts, the percentage of possible duration ranging from 46% in the English Channel to 24% in Scotland N., which was just double the average in each case. The sunniest station was Salcombe, 32·5 hours (58%). At Westminster the aggregate was 12 hours (22%). The temperature of the sea water varied from 39° at Ballantrae to 51° at Scilly.

The week ended December 16th was mild and wet. Slight thunderstorms were reported, and Aurora was seen in Scotland on the 11th and 14th.

Temperature was above the normal in all districts, the excess amounting to nearly 4° in England S.E., and the Midland Counties. The highest reading was 55° at Waterford with 54° at several stations. The lowest of the minima were 23° at Balmoral, 27° at Killarney, and 29° at Nairn. At no other station did the temperature fall below 30°, and indeed in six out of the eleven districts into which the United Kingdom is divided for Meteorological purposes the temperature did not fall below the freezing point. In the English Channel the lowest reading was 41°. On the ground the lowest temperature reported was 20° at Balmoral.

Rainfall was greatly in excess, except in Scotland N. Falls of more than an inch in twenty-four hours were frequent, and at Crathes the fall on the 15th amounted to 2·03 inches. At many stations the total for the week was more than double the average. Sunshine was also in excess of the average over the greater part of England though slightly below in Scotland and Ireland. The sunniest district was England E., with 15 hours (29%); the sunniest station being Torquay with 19·3 hours (35%). At Westminster the total was 10·9 hours (20%). The temperature of the sea water ranged between 40° and 50°.

RAINFALL AND PHTHISIS. — A [illegible] Walter [illegible] R[illegible] D[illegible] [illegible] with [illegible] bearing [illegible] of [illegible] R[illegible] Sanitary District [illegible] classified the parishes [illegible] the several areas according to their exposure to the W. and S.W. winds, which in Devon are the rain winds, into I, sheltered parishes, II, exposed parishes, and III, imperfectly sheltered parishes, and then carefully collated the deaths from phthisis in these parishes during a series of years.

To his great surprise he found that the death-rate in the parishes exposed to W. and S.W. winds was generally double, sometimes more than double, that in the parishes sheltered from those winds, and this irrespective of the *amount* of the rainfall in the various places. Thus, of two contiguous parishes with a hill between them the parish on the windward side of the hill was found to have twice as many deaths from phthisis, per thousand of the population, as that on the side sheltered from the S. and S.W., but exposed to the N. and E., and this although the amount of the rainfall on the leeward side of the hill was in many cases greater than that on the windward side.

The areas selected were situate, two in the northern part of the county and two in the southern part, and the results were so consistent as to justify further inquiry. This further inquiry was conducted both in detail and on a broad scale, and the results arrived at fully confirmed those first reached. In the wider inquiry the various counties were taken as units, and subsequently larger areas still; in the detailed inquiry the City of Exeter was taken, street by street, and both lines of research led to the same result, namely, that the important point to consider in the choice of a residence for persons suffering from phthisis is the incidence of the rain-bearing winds of the locality, exposure to which is a more serious factor than the altitude of the place, the character of its soil, or even the amount of its rainfall.

MICROSCOPY.

By [illegible]

with the assistance of the following microscopists:

Arthur C. Banfield. — Arthur Earland, F.R.M.S.
The Rev. E. W. Bowell. — Robert T. Lewis, F.R.M.S.
James Burton. — Chas. F. Rousselet, F.R.M.S.
Charles H. Caffyn. — D. J. Scourfield, F.R.M.S.
C. D. Soar, F.L.S., F.R.M.S.

AN INTERESTING EARTH MITE UNRECORDED IN GREAT BRITAIN. — One Summer day in 1909, I was seeking in my garden for some fresh mites or spring-tails, and so on, when I saw on the stone steps leading up to the [illegible] a mite [illegible] moving at a very rapid pace, and [illegible] in quite an [illegible] manner. It was advancing in a zig-zag manner, but in the form of curves, each curve being about five to six inches long, and advancing about one to two inches at a time. Sometimes it would make a wider sweep of about half a circle, and occasionally, when apparently it came across an active prey, it would whirl round in small concentric circles with such velocity as to envelop and secure it, and sometimes it would stop so suddenly that the eye was carried on and for the moment lost the mite.

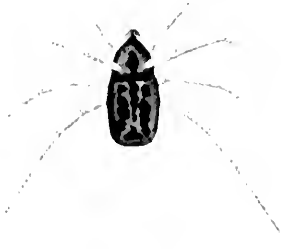


FIGURE 42.
Dorsal surface × [illegible] showing the so-called ear-like processes.

As an instance of the ferocity of this mite, I saw a Spring-tail, I believe a *Degeeria*, several times the size of the mite, resting on a window-sill. The mite was advancing in its usual zig-zag manner towards it, but not seeing the spring-tail until within six or eight inches from it; then the mite rushed at the spring-tail. For a moment the turmoil was something to see, but it ceased as suddenly as it had begun, the mite was alone, the spring-tail having escaped with a motion too rapid for the eye to notice. Having moved in March, 1910, to another part of Plymouth, I was afraid I had lost my little visitors, especially as I did not find them at the old home, which I occasionally visited for that purpose; no doubt it was mainly owing to the inclement year, but to my delight in the early summer of this year (1911) I found them busy on my window-sill, and again on a low wall underneath my window. Apparently they nested in the border bell-flower (*Campanula carpatica*), which I had sent up to my new abode, a singular coincidence that this mite living amongst hundreds of blue bells, should be furnished with ears.

FIGURE 43.
Side view of Palpus × 150. Inside, showing the two teeth. Drawn from a male specimen. Male and female alike.

FIGURE 44.
Foot of fourth leg × 160.

I found on placing the mite under a low power, × 35, that it was a dark orange-red mite with brown markings, but with two perfectly white ear-like processes (in shape triangular), situated immediately behind the eyes. Then putting it under × 200 I saw a beautiful comb-like arrangement under and across the end of the abdomen, and projecting beyond it. This I found afterwards to be the male. The female is in all respects like the male, except it is without the comb-like process shown in Figure 46.

FIGURE 45.
Method of carrying palpi in front. Drawn from the front of an unmounted specimen × 160.

I have always found it active, seeking its food on stone, and never on flowers, flower bed, or grass adjoining. I have also found them on my bedroom window-sill, about twenty feet from the ground, where a pair had taken up their abode between the wood and stone-work, so I hope next summer to have a further and better opportunity of studying them. The front of the house over which they travelled is built of stone.

FIGURE 46.
[illegible] ventral [illegible] male showing [illegible] arrangement [illegible] testes, × [illegible]

Erythracarus parietinus Herm.

It is apparently *Erythracarus parietinus*, Herm., but neither Hermann's figure 1804, nor Koch's 1835-41, nor Berlese's, have the ears which is such a beautiful and distinct character in this mite, so it would appear to be:—As *Erythracarus parietinus* with ears. Super family, Trombidoideæ; family Erythraeidæ; genus Erythraeus [illegible] since altered by Berlese to *Eryt*[illegible] the [illegible] *Erythraeus* is a Rhyncholophus.

References: Hermann, J. F., "M[illegible] Aptérologique," page 37. Table 1. Figure 12. Strasbourg, [illegible]04.

Koch, K. L., "Deutschlands Crustaceen [illegible]" [illegible] 23.

Berlese, F., 11, No. 4, Figure 2.

The length of the mite is 0·96 millimetre. The figures to illustrate my note were kindly drawn by Mr. Chas. D. Soar, F.R.M.S.

A. W. ALLEYSTER.

DARK GROUND ILLUMINATION AND ULTRA MICROSCOPIC VISION.—The letter on the above subject by Mr. E. Leitz is of considerable importance, for it is eminently desirable that a proper understanding of the province and limitation of the accessory apparatus used in the production of dark ground illumination should be clearly defined.

Particularly striking is the fact mentioned by your correspondent, that neither dark ground illumination nor the so-called Ultra Microscope is a means of enhancing the resolving power of the Microscope. Mr. Nelson pointed this out some considerable time ago, and it has now been ascertained that for an objective to utilize its full resolving power the numerical aperture of the Dark Ground Illuminator must be three times that of the Objective. As under present conditions the maximum numerical aperture of the Illuminators is 1·35, it follows that the effective aperture of all Objectives exceeding ·45 is reduced. There is actually a greater resolving power with dark ground illumination with Objectives having numerical apertures in excess of ·45, but it is very substantially less than that which is yielded with direct light, so much so that if we take 1·35 as the limit of numerical aperture for both condenser and objective, the resolving power obtainable with dark ground illumination is approximately that yielded with a numerical aperture of ·65 with ordinary direct illumination, while if the practical limit of the objective be considered, namely 1·0 N.A., in connection with a condenser of 1·35, the resolving power obtained is only equal to that of an objective of ·59 with direct illumination. It therefore follows that the perception of fine structural detail is not so much a feature with dark ground illumination as the increased contrast afforded, and the practical advantage of the use of high powers lies chiefly in the greater magnification.

The well-known phenomenon of a streak of sunlight passing through a small opening into a darkened room revealing dust particles which in full daylight cannot be seen, is the explanation of the effect produced in microscopical dark-ground illumination when minute particles otherwise invisible are revealed, and even with so simple a piece of apparatus as the spot lens with a one inch objective, starlike objects and specks which by direct illumination would be invisible are clearly seen and come under the category of "ultra-microscopic." And so through the whole range of dark ground immersion condensers, and finally the special apparatus known as the "Ultra-Microscope" the same law applies, only the method differing, and there is the same limited resolution that is implied by the physical limitation of the total numerical aperture of the condenser referred to previously.

Undoubtedly great confusion has arisen in the minds of microscopists in consequence of the multiplication of dark ground illuminators of various kinds, especially those which have enabled objectives of high magnification to be employed, and for the sake of clear understanding, and to avoid any chance of confusion, it would be well to sharply differentiate the apparatus into three classes:—

1. To comprise the Spot Lens and all the means until recently provided for low power dark ground illumination, which might be classed as "Low Power."
2. All [illegible] the [illegible] objective, and particularly the [illegible] Systems, and [illegible] which could be [illegible] Power.

And finally, the [illegible] arrangement which depends on illumination [illegible] right angles to the optical axis through [illegible] could be known as the "Ultra-Microscope."

I commend the [illegible] to the consideration of your readers, with the hope that someone more capable than myself may pursue the matter further.

M. E. CROSS.

A NEW MICROSCOPE.—W. Watson & Sons, Ltd., have recently introduced a Microscope of new design, the "Bactil Mk. IV." which follows the lines of some well known Continental models, but combines the special features which distinguish all the Watson Microscopes. See Figure 47.

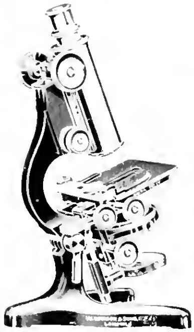


FIGURE 47.

It will be noticed from the illustration that the fine adjustment is set on the side of the limb, the rotation of the controlling milled head being read on a divided drum. This milled head actuates a lever set in a vertical position. The freedom from complications, certainty of action, and the very slow movement that can be obtained is well known in the lever form.

The mechanical stage is not of the usual attachable kind, but is built to the instrument and gives a horizontal range of movement of two inches. A very neat feature of this stage is the method of gripping the object slip. Hitherto this has been dependent on a spring action pulling down a curved finger piece. This has always been open to the objection that the immersion oil, especially if thick, exercised a retarding influence on the slip, and this, pressing against the spring referred to, caused it to give very slightly, with the result that when high powers were in use there was an apparent loss of time on change of direction of the mechanical screw of the stage. This is obviated in this new pattern, the finger-piece being set by means of a milled head, and being immovable excepting by its means.

By an ingenious arrangement the whole of the stage can be removed from the dove-tailed fittings and a plain stage substituted for it if desired.

The substage is of the regular English pattern with rack work to focus and screws to centre. It also lifts aside from the optical axis.

The spring fittings to frictional surfaces, the large body tube, the long range of coarse adjustment for use with low power objectives, the advantage of which is so well-known, are retained in this model. It is of solid and handsome construction throughout.

APPARATUS TO FACILITATE THE ILLUMINATION OF OPAQUE OBJECTS WHEN VIEWED BY THE AID OF THE VERTICAL ILLUMINATOR (Figure 48).—This apparatus, suggested by Mr. J. E. Barnard, F.R.M.S., consists of a small right angle prism, fixed to an arm, which is clamped to the nosepiece of the microscope by the screw of the vertical illuminator, and has universal movements. It will be found most useful when photographing opaque specimens such as metals, and so on. In use the Microscope Stand is placed in a horizontal position and the illuminating beam thrown by the aid of a bullseye condenser upon the right angle prism; it is then projected through the diaphragm of the vertical illuminator, and so on through objective to specimen; the diaphragm of vertical illuminator must of course be directly under the right angle prism. By this means of illumination the position of vertical illuminator may be varied when objectives of different power are used without the beam of light being altered, one of the inconveniences experienced when the vertical illuminator is illuminated from the side, and to overcome which many metallurgical microscopes are provided with rack adjustment to the st[illegible]

[illegible]

[illegible] MICROSCOPICAL SOCIETY. [illegible]

[illegible]

The Society exhibited, under Microscopes, a number of slides of Rock sections from Australasia, presented by Mr. H. J. Grayson and cut by him by his improved apparatus. Mr. J. E. Barnard read a paper on "A Geometric Slide Photomicrographic Apparatus." Mr. Barnard said the apparatus was designed on the principle of the geometric slide throughout, as enunciated by Lord Kelvin and Tait. The base of the apparatus was formed of two castings designed on the girder principle, braced together at each end and in the middle. The portion to carry the microscope was also formed by a pair of castings braced together in the same way. Great rigidity was obtained, and the whole apparatus could move together if subjected to shock or vibration. Rods were fastened down on the top of the castings to support the apparatus, and the camera slid along these on two V-grooves on one side and on a plane surface on the other side. The [illegible] were supported on vertical rods fixed on the [illegible]. The apparatus could be used equally well as a horizontal or vertical camera, or at an angle of 45°.

A paper on *Fridericia*, by Rev. Hilderic Friend, F.L.S., was read. The genus *Fridericia* was created by Michaelsen, in 1889, to receive certain species of Enchytraeids, eleven in number, possessed of dorsal pores, and having setae of unequal length. In 1895, Beddard reckoned twelve species, but not one was known as British. Moore, Friend and others added to the list which in 1900 stood at twenty-one. Bretscher, Issel and others then took up the study, and at the present time some seventy or eighty species of *Fridericia* are known to science. The largest is *F. magna* Friend, which has been found in England, Ireland and Scotland, but has not been reported abroad. The author, whose researches on this genus began in 1890, here reports no fewer than [illegible] species found up to the present time in the British Isles.

QUEKETT MICROSCOPICAL CLUB. [illegible]

[illegible] It has been estimated [illegible] that the [illegible] the general name "Insects," are [illegible] in its effects both for good and evil. The part played by insects in connection with disease is threefold. (1) as actual parasites; (2) as mechanical transmitters; (3) as intermediate hosts of pathogenic organisms. Specimens of each of these classes were exhibited and described. A list was given, under the third group, of the diseases transmitted and the hosts responsible for their spread. To Mosquitos are due Malaria, Yellow fever, Elephantiasis and Dengue in man; Horse-sickness in Transvaal, and Filariasis in man. The Tsetse fly is responsible for Sleeping-sickness in man and Nagana in horses and cattle. The Tabanidae cause Surra in cattle; *Stomoxys*, Mal de Caderas in horses; *Hippobosca*, Galziekte in cattle; Fleas transmit Plague; Sand-flies, Pappataci Fever in man; Ticks, Relapsing Fever in man, and Texas, Redwater, Rhodesian, Biliary, and other fevers in cattle, horses and sheep, Spirochaetosis in fowls and Malignant Jaundice in dogs. And who can say how many more? Several of the more important of these diseases were described at length and an interesting account was given of the prophylactic measures adopted. One of the first problems to be solved in this connection is the distribution and life history of all blood sucking insects, an enormous task, but one that is being slowly and surely accomplished.

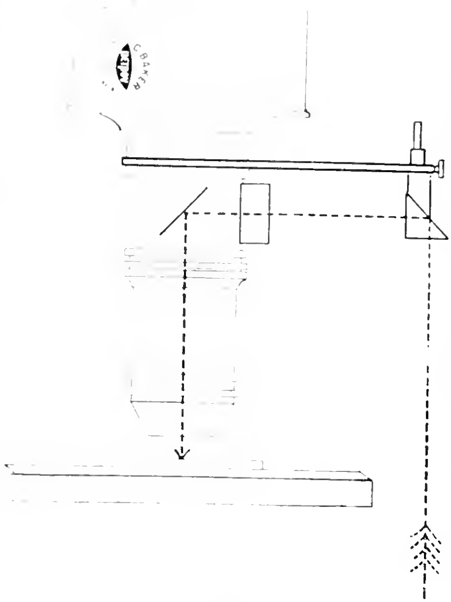


FIGURE 48.

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

WILLOW GROUSE IN SCOTLAND. Last shooting season (1911) three white Grouse were shot at Glendaruel, Argyllshire, and seem to have been something of a puzzle to the shooting party at the time. It is explained, however, that on the neighbouring estate of Glenstriven some Ryper (*Dalripa*, Swedish) or Willow Grouse (*Lagopus albus*) which had been sent from the far north of Sweden, were put down some years ago in the month of April. They were placed in an enclosure on the hill with one wing slightly clipped, but they soon escaped and were scattered about the country. The remains of two or three, killed by hawks, were found; and those now reported shot are probably others which survived till then. (*The Field*, 18th November, 1911, page 1129.) Our native Red Grouse (*L. scoticus*) and the Willow Grouse have separate geographical ranges, but they are of common origin and the last-named might well establish itself as a breeding species in Scotland, given the opportunity, to which ornithological purists are strongly averse. It has, however, been turned down on several shootings, and in Banffshire, in 1909, it was reported to be so much at home as to breed pretty freely with the Red Grouse, the offspring turning out shapely, vigorous and healthy.

COMMON BIRDS NESTING AT HIGH ALTITUDES. In the British Isles the nests of a few species of birds are found only at a considerable elevation above sea level, but some of our common birds associated with the lowlands are occasionally found making their homes upon the hills. Last summer (1911) Mr. Seton P. Gordon saw, on 28th July, a Swallow's nest with one fresh egg at an old shooting lodge in the vicinity of a Highland loch at an altitude of about one thousand six hundred feet, and he remarked that it closely resembled that of a Grey Wagtail which had nested on the same beam (*Country Life*, 11th August, 1911, p. 270). The Swallow's near neighbour, the House-Martin, was breeding in numbers at the beginning of August under the eaves at Swarthgill, the highest-up house in Wharfedale (about one thousand three hundred feet). Further north, and at the same elevation (one thousand three hundred feet), on the Lui Water, Mar Forest, Aberdeenshire, there used to be (1902 and 1903) a nesting colony of about thirty pairs of the delicate little Sand-Martin and the spot may be still frequented. On the great Deeside Hill, Lochnagar, on 7th July, 1903, three pairs of Swifts were found to be haunting the highest summit (three thousand seven hundred and eighty-six feet). They kept going in and out of a crevice which could not be got at, but it was well seen in the brilliant sunshine of a very fine day and the birds were kept under observation for about an hour. Enquiries failed to ascertain if there was positive proof that they were nesting, and an opportunity of re-visiting the place has not yet fallen to our lot.

RECOVERY OF MARKED BIRDS.—Some further returns are given in the December number of *British Birds* (V, pages 186-188), the most noteworthy being:—

Linnet (*Linota cannabina*)—marked at Hampton-in-Arden, Warwickshire, 26th May, 1911; recovered near Bordeaux, France, 25th October, 1911. Another marked near Reading, Berks, 6th June, 1911; recovered at Sabres, Landes, France, 25th October, 1911.

Starling (*Sturnus vulgaris*)—marked at Viborg, Denmark, 7th October, 1911; recovered near Shropham, Norfolk, 12th November, 1911.

Cormorant (*Phalacrocorax carbo*)—marked at Saltee Island, County Wexford, 26th June, 1910; recovered at Audierne, Finistère, France, 16th November, 1911.

Common Tern (*Sterna fluviatilis*)—marked at the Summer Isles, Ross-shire, 5th August, 1911; recovered near Oporto, Portugal, at the beginning of October, 1911. Another marked at Loch Thom, Renfrewshire, 22nd July, 1911; recovered near Aveiro, Portugal, 11th October, 1911.

Black-headed Gull (*Larus ridibundus*)—marked in Schleswig, 25th June, 1911; recovered at Breydon, Norfolk, 27th October, 1911.

COMMENSAL NESTING.—One of the photographs in Mr. Clinton G. Abbott's recently published book on "The Home-Life of the Osprey" (1911) shows a large nest on a tree-top in Gardiner's Island, near New York. An Osprey is sitting by the nest and a Purple Grackle about to enter its home in the same nest, and also a Woodpecker's hole in the branch of the tree directly below. Mr. Abbott explains that smaller birds often use the sides of the Osprey's huge abode to nest in, and that Purple Grackles especially, being gregarious, may be found to the number of six or seven pairs in one nest-structure. They live in perfect harmony with their host. House-Sparrows have been seen by Mr. Abbott utilizing Ospreys' nests and House-Wrens and even Night-Herons have been recognized elsewhere as its tenants. In nests on the ground Meadow-Mice construct their run-ways in the mounds. Such nesting 'partnerships are unusual amongst birds, but the Ospreys and their tenants undoubtedly find some mutual advantage in this close association.

THE FLIGHT OF BIRDS AS SEEN FROM A MOTOR CAR. A correspondent writes: "Running along these country roads an observant eye will see a good deal of life. Birds, startled by the sudden appearance and strange sound, fly out from the hedgerows, as often as not crossing the road immediately in front, uttering their notes of alarm, whilst some will fly in front or alongside for some distance before they swerve aside to alight in a convenient field. The apparent ease with which many of the smaller birds will keep up with, and even gain upon, a car which is travelling at the rate of twenty-five and more miles an hour, provides a startling illustration of their different powers of flight. Twenty to twenty-five miles an hour seems to be about the ordinary speed in flight of most of the birds inhabiting the hedgerows. Other birds, such as the swallow, will, in their ordinary flight, pass a car when it is travelling at as high a speed as forty miles an hour."

THE BODY TEMPERATURE OF BIRDS. At a meeting of the Royal Society of Edinburgh, on 20th November last, a communication on "Observations on the body temperature of some diving and swimming birds" was made by Professor Sutherland Simpson, M.D., D.Sc. He said that observations had been made on the body temperature of a large number of diving and swimming birds of eighteen different species in the Orkney Islands and in the Firth of Forth, in Scotland, and on and around Cayuga Lake, New York, U.S.A., immediately after they were killed by shooting. In all the species examined where the sex was determined it was found that the temperature of the male was slightly below that of the female. Of the orders examined the highest temperatures were found in the Longipennes, and the lowest in the Tubinares. When arranged according to body temperatures the series did not run parallel with the zoological series.

PHOTOGRAPHY.

By EDGAR SENIOR.

PRINTING WITH SALTS OF IRON, URANIUM, AND SO ON.—Having had occasion lately to make a number of prints in which the salts of iron, chromium and uranium were the sensitive agents, it was thought, from the beauty of the results obtainable, together with the simplicity of the process, that the subject might form matter interesting to photographic students, and those requiring a method for readily obtaining a record of general forms of objects such as seaweeds, fern or other leaves, lace, and so on. The general principle upon which the formation of the images is based is that of reduction, light reducing the ferric and uranic salts to ferrous and uranous, and these, when treated with certain re-agents, producing suitably coloured deposits. For nearly the whole of our knowledge concerning the action of light upon iron salts we are indebted to Sir John Herschel, whose experiments date back nearly seventy years. The iron salt usually employed as giving the most certain results is that known as the double citrate of iron and ammonium citrate, which is obtainable in two varieties in the form of scales, one of which is brown, the other green, in colour. We much prefer the green scale preparation, as it is more sensitive, and gives better results generally. Whichever preparation is used, a solution is made containing about forty grains dissolved in one ounce of distilled water; or, in the case of the green scale preparation, enough of the salt may be taken to make quite a dark green-coloured solution, no weighing being necessary.

Paper, "ordinary writing paper answers perfectly," is coated with either of the above by means of a piece of sponge or cotton wool used for filtering purposes, spreading the solution evenly over the surface with a circular motion. The coating operation should be performed by artificial light or in a dimly lighted corner of a room. The paper may be dried in front of a fire, taking care not to scorch the surface, and is then ready for exposure, or it may be kept between the leaves of a book for some short time until required for use. Our own experience however is, that freshly prepared paper answers best.

The object from which it is desired to obtain an image is laid upon a piece of glass placed in a printing frame, and the paper placed with its coated surface in contact; the whole is then exposed to light for a time varying from five minutes in a bright light to twenty minutes or more in a dull one. However, as the change brought about is a visible one, the progress of printing may be watched, examining the print in some well-shaded position; especially is this necessary with paper prepared with the green ferric ammonium citrate, on account of its increased sensitiveness.

If ordinary negatives are used to print from (and excellent results can readily be obtained in this way) care must be taken not to over-expose; in fact, the printing must not be carried to such a stage that the detail in the lights becomes visible, otherwise a general flatness of the picture will result. The negatives employed must be fairly strong ones, it being useless to attempt to use poor thin ones. The change in colour during exposure to light is from a greenish-yellow to a pale greyish brown, a little experience soon enabling one to judge when the printing has been carried far enough. On removal from the printing frame development may take place at once, or the paper may be placed in a book until a more convenient time. Experience, however, shows that too long a time should not be allowed to elapse between the two operations. In order to develop the print it is laid face upwards in a porcelain dish, and a solution of potassium ferricyanide (red prussiate of potash) of about twenty grains in an ounce of water poured over. Development is almost instantaneous, the print assuming a fine blue colour due to the ferrous salt resulting from the action of the light reacting with the ferricyanide of potassium, and producing a precipitate known as Turnbull's blue, having the composition $Fe_3Fe_2Cy_{12}$. After development the prints are placed in water containing a little sulphuric or hydrochloric acid, then washed in several changes of water and dried. Prints made by this process are very stable, although soaking in water certainly weakens them. A variation of the process may be made by applying to the exposed paper a dilute and neutral solution of gold chloride, when a purple image results, owing to the ferrous salt reducing the gold salt to the metallic state. Sir John Herschel gave the name of Chrysotype to these prints.

A variation in the method described above by which blue prints may be obtained direct without development may be made by mixing together the ferricyanide of potassium and the ferric salt, and applying the same to paper. The following will be found a good formula:

1.

Potassium ferricyanide	60 grains
Water (distilled)	1 ounce

2.

Ferric ammonium-citrate	70 grains
Water (distilled)	1 ounce

These two solutions should be mixed together and kept in the dark. When required for use a little is taken and spread over paper, as already described, which when dry is ready for use. When the action of light has gone far enough, "which is ascertained by examination," the print is removed from the frame and placed in water containing a few drops of sulphuric acid, and afterwards washed in several changes and placed to dry. To make uranium prints the same procedure as described above is employed, using a strong solution of uranium nitrate of about one hundred grains in one ounce of water in place of the ammonio-citrate of iron. Development of the prints with potassium-ferricyanide gives brown prints. If we mix uranium and the iron salt, and apply this to paper, a grey print results on development; in fact, mixing of the salts in varying proportions is found to give, in many cases, rather pleasing results.

EXPOSURE TABLE FOR JANUARY. Although weather conditions during the next month or two may not be altogether conducive to outdoor photography, there may be occasions when opportunities present themselves for this class of work. We therefore give a table containing a few exposures that may be found useful. The calculations are made on the actinograph for plates of speed 200 H. and D., the object a near one, and lens aperture f/16.

Day of the Month	Condition of the Light	Time of Day: 11 a.m. to 1 p.m.	10 and 2	3 p.m.	Remarks
Jan. 1st	Bright	4 sec.	[illegible] sec.	10 sec.	If the subject be a general open landscape take half the exposures given here.
" "	Dull	8 "	10 "	20 "	
Jan. 15th	Bright	3 sec.	4 sec.	6 sec.	
	Dull	6 "	8 "	12 "	
Jan. 30th	Bright	2 sec.	3 sec.	5 sec.	
" "	Dull	5 "	6 "	10 "	

PHYSICS.

By Alfred C. G. Egerton, B.Sc.

THERMOSTATS. The Faraday Society's Meetings are always marked by a degree of general usefulness, interest, and enthusiasm which is sometimes lacking in the proceedings of older societies. On Wednesday, December 6th, among the subjects for discussion was that of the construction and working of thermostats. Thermostats are arrangements for maintaining temperatures constant over a long period of time and are most necessary accessories to the study of most physico-chemical processes.

A thermostat consists generally of a bath of liquid which is maintained constant in temperature by means of a heater placed either inside or outside the bath. The heater, if used inside the bath, consists either in a bare electric resistance wire or an electric lamp; if used externally the heating is usually accomplished by means of a small gas burner. In each case some form of thermo-regulator, which switches on and off the current or turns the gas up and down, has to be employed. This thermo-regulator usually consists of a closed tube of liquid with low specific heat, high expansion coefficient, and small density which expands on rise of temperature; the liquid then presses on one side of the mercury contained in a U-tube, which on being raised in the other limb of this tube, closes either an electric circuit or the end of a tube through which the flow of gas to the burner is passing. In the first case, the electric current actuates an electro-magnet which switches out the electric heaters; in the other case the supply of gas is automatically cut down by closing the end of the tube mentioned and can only issue through a small opening in the side of this tube. An efficient stirring arrangement has to be used in the baths, otherwise a constant temperature cannot be maintained. These stirrers are constructed like a "screw" and are actuated by means of an electric motor.

Dr. Lowry has improved the thermo-regulator by making the tube containing the expanding liquid (usually toluene) as large as possible, so that the maximum amount of surface is exposed: there is then very little lag in the action of the regulator. This is accomplished by making the tube of spiral form.

Dr. Marshall gave a number of valuable hints as to the working of electrically controlled thermostats. The form of electric heater he advocates, is a form of elongated electric lamp which is switched in and out as before described, only the thermo-regulator actuates a relay which then switches out the main circuit; the relay being actuated by a single secondary cell kept permanently on the charge. A relay is a sensitive electro-magnet which responds to a weak current and makes an electric contact, which brings into action an electric current from a stronger source. The object of this is to obviate pernicious sparking on breaking the contact at the mercury surface of the thermo-regulator. Dr. Marshall also described a method of employing an ice thermostat for maintaining constant temperatures from 12° C. to 0° C. This type of thermostat belongs to a different class, in which advantage is taken of the fact that substances melt and boil at constant temperature. Mr. Bousfield described a temperature regulator for use in an air bath. It consists of a large bulb of glass containing hydrogen. When this hydrogen is raised in temperature it expands and increases the pressure on a column of mercury in a barometer tube. When this occurs an electric contact is broken which switches out the electric heater. The mercury does not get attacked, because the circuit is broken in an atmosphere of hydrogen.

It is not easy to obtain a satisfactory method of maintaining constant low temperatures over a long period of time. There are a limited number of substances which can be used to maintain constant low temperatures, e.g., boiling sulphur dioxide (−10° C.), boiling liquid ammonia (−33 C.), boiling sulphuretted hydrogen (−61° C.), boiling nitrous oxide (−83 C.), and boiling oxygen (185° C.); also melting ether, melting nitrous oxide, and various "freezing mixtures," such as solid carbon dioxide and ether. But in all these cases a considerable quantity of the pure liquid is required, and the liquefaction is a troublesome process. Further, if these liquids are contained in a Dewar vessel, they supercool themselves unless evaporated by an electric heating arrangement.

The writer has recently been employing an arrangement for maintaining temperatures constant over a range of temperatures between +80 and −150 C., but has not yet published the method, as the details are hardly yet worked out. The general principle is that the thermometer, on rise of temperature of the bath liquid, makes an electric contact which switches in a heating coil situated in a closed bulb containing the bath liquid (e.g., petrol); this bulb communicates with a spiral containing the same liquid immersed in a refrigerating agent; on heating the petrol in the top bulb, the pressure rises there and forces cold liquid from the spiral into the Dewar vessel which contains the bath liquid. The electric contact, owing to the fall in temperature, then breaks, and the liquid is sucked back into the spiral and recooled.

THE YEAR 1911.—It would not be possible to review the many advances made in the physical sciences during the year 1911 in the space of a few lines. One might direct attention, though, to the main regions of activity. There are usually one or two problems upon which the mind of man is concentrating its attack; other points in the line of resistance of the enemy remain in a more or less quiescent state. In radioactivity, Professor Rutherford and his collaborators have, by means of the beautiful scintillation method, investigated the scattering of the rays by atoms of various substances and have obtained valuable evidence on which to gain an idea of the structure of the atom. Professor Sir J. J. Thomson has concentrated his attention on the rays of positive electricity which stream back through a hole in the cathode of a tube in which a high vacuum is maintained. Others have investigated the positive rays emitted by incandescent solids and analysed the intricate actions which occur with some success. Secondary rays emitted from materials bombarded by X rays or corpuscular radiations have proved to be a problem of great interest and about which considerable controversy has been raised, Barkla and Bragg being the champions of the two views as to the nature of X rays. Then again there are the intensely interesting results of Professor Strutt, who has obtained a chemically active modification of nitrogen by means of an electric discharge, and has explained *en route* the peculiar glow effect obtained in certain circumstances with such discharges. Professor Woods' researches on the fluorescence from certain vapours lead to an idea of the vibrations and groupings of the electrons within the atom.

Professor Callendar has pointed out how the old idea of caloric may be of use in the study of thermodynamics, while the mechanism of the osmotic pressure of liquids is beginning to reveal itself. The motion of liquids in pipes and of solids through liquids has been submitted to careful experiment with useful results; while finally the theory of radiation and also of electric conduction and other fundamental physical properties has been advanced by means of what is known as the relativity principle, to which it will be well to devote a little space in the notes of the month of February or March.

ZOOLOGY.

By Professor J. Arthur Thomson, M.A.

LARGE CUTTLEFISH.—It is always satisfactory to have precise figures in regard to big animals, and no fault can be found with the precision with which Mr. S. S. Berry has recorded the dimensions of a huge cuttlefish from Monterey Bay. Its total length was 1245 millimetres, that is rather over four feet; its length of body was 1180 millimetres. Its name is *Dosidicus gigas* (d'Orbigny) Pfeffer, and it is remarkable, in addition to its size, for some peculiar features in the suckers of the tentacles. The fine specimen is preserved in the University of California.

SELF-ADVERTISING ANIMALS.—Some animals walk delicately, some lie low, some fade into their surroundings, some put on disguise. On another tack, however, are those that are noisy and fussy, conspicuous and bold, the self-advertisers. The theory is that those in the second set can afford to call attention to themselves, being unpalatable or in some other way safe. Mr. Pocock, of the Zoological Society's Gardens, has been recently applying this theory to various mammals, both at home and abroad.

Taking the common shrew, for instance, he points out that it is fearless and careless, and that it makes a frequent squeaking as it hunts. It can afford to be a self-advertising animal because of its strong musky scent, which makes it unpalatable. A cat will never eat a shrew. Similarly, the large Indian musk-shrew (*Crocidura coerulea*) is conspicuous even at dusk, fearless in its habits, and goes about making a peculiar noise like the jingling of money. But it is safe in its unpleasant musky odour.

The common hedgehog is comparatively easy to see at night; it is easy to catch, because it stops to roll itself up; it rustles among the herbage and "snuffs furiously" as it goes; it is at no pains to keep quiet. Nor need it, for although some enemies sometimes eat it, it is usually very safe, partly in its spines, and partly because it can give rise to a most horrible stench. The porcupine is another good instance of a self-advertiser, and so is the crab-eating mungoose (*Mungos cancrivora*).

HOW MUCH DOES A MOUSE SEE?—To look at a mouse one would think that sight counted for a great deal in its life, but Mr. K. T. Waugh's experiments go to show that this is only true within certain limits. Mice are good at distinguishing different degrees of illumination and different colours (preferring red and yellow to blue and green), and they are quick to detect movements, but they have very little sense of form and very little binocular vision. Microscopic study shows that the retina has no "rods" and no "fovea."

BRITISH FOSSIL SHREWS.—The remains of shrews found in the Norfolk "Forest Bed" and other British Pleistocene deposits have been hitherto referred to one or other of the three species at present inhabiting the country, namely *Sorex araneus* (or *vulgaris*), *Sorex minutus*, and *Neomys* (or *Crossopus*) *fodiens*. But a careful inquiry recently made by Mr. Martin A. C. Hinton shows that it is not until we reach the latest Pleistocene deposits that we meet with remains of species apparently indistinguishable from the living British forms. According to Hinton we must recognise at least three extinct species of *Sorex* and two of *Neomys*. He regards *Sorex* as standing in most respects on a slightly lower plane than *Neomys*. It retains one more premolar above; in the large lower incisor three or four denticles (primitively present upon the crowns of mammalian incisors) persist until an advanced stage of wear has been reached; the condyle of the lower jaw and its articulation are less highly modified. "In the small size of most of the species, their external characters, and the form of the skull and humerus we see the effects of an adaptation to life underground." The water-shrew (*Neomys*) has gone a little further and in a different direction, in adaptation to aquatic life, which has to some extent influenced its external characters. "A premolar has been lost above; the large lower incisor has been simplified—only one of the primitive denticle (in addition to that forming the point of the tooth) persisting, and the peculiar modification of the mandibular condyle, and the glenoid cup into which it fits, has proceeded further." Mr. Hinton has paid considerable attention to the dentition of the shrews, and it may be useful to note the formulae which he regards as most accurate:—

$$\text{For } Sorex \quad i\ \frac{1.2.3}{1},\ c\ \frac{1}{1},\ pm\ \frac{4.3.1}{1},\ m\ \frac{1.2.3}{1.2.3} = 32.$$

$$\text{For } Neomys \quad i\ \frac{1.2.3}{1},\ c\ \frac{1}{1},\ pm\ \frac{4.\ .1}{1},\ m\ \frac{1.2.3}{1.2.3} = 30.$$

DOES A SNAIL SEE?—Field observations on the vineyard snail, *Helix pomatia*, suggest that the animal avoids the light. Willem's laboratory experiments, on the other hand, suggest that it prefers the light. Professor Emile Yung, of Geneva, has re-investigated the question, and finds that both these conclusions are wrong. He made over two thousand observations on one hundred and seventy-six snails, and found that they were quite indifferent to all sorts of light-stimulus, that they do not prefer lighted or shaded areas, that they do not see obstacles in front of them, and that their eyes have no visual significance at all.

EXOTIC CRUSTACEA IN BOTANIC GARDENS.—R. Menzel calls attention to the opportunities of studying exotic animals without leaving home. In the palm-house tank, in the Botanic Garden at Basel, he found an exotic *Cypris* (or *Stenocypris*). Outside he found *Cypretta* (*Cypridopsis*) *globulus* Sars, which has been described from Australia. Under flower-pots with earth brought from Java, he found what seems to be a new species of *Orchestia* (*O. senni*), doubtless of exotic origin, and interesting in being thoroughly terrestrial.

ASSOCIATION OF SUBERITES AND DROMIA.—A bright orange sponge (*Suberites domuncula*) is often found surrounding the gastropod shells inhabited by hermit crabs, but the association has not been sufficiently studied. The sponge is unpalatable to many animals; it is full of strong flinty needles, and it has a strong odour. At the Naples Zoological Station Signor Polimanti has been recently studying the association between the Suberites and a crab (*Dromia vulgaris*). He has made this much quite clear, that the crab takes the initiative in getting the sponge on to its back and that the sponge affords its partner an effective protection against the appetite of cuttlefishes.

SELF-CLOSING PLANKTON NET.—Professor C. A. Kofoid describes a new model of Plankton net which he has tested extensively. The advantages which it has over other models are the following: It can be opened or closed by the operator at any desired level in the sea, and it is not liable to interference from outside conditions. There is perfect and continuous closure of the net during descent and ascent. Nothing can enter, nothing can escape, unless the operator opens the net. The possibility of horizontal towing makes it feasible to effect a precise exploration of stratified waters. The vertical migrations of pelagic organisms can also be studied more effectively than before. The opening of the net is free from bars and ropes, which tend to ward off the more active animals. Professor Kofoid also describes a new self-closing water bucket, by which it is possible to collect twenty litres from any desired depth.

NOTICES.

A METEOROLOGICAL CATALOGUE.—We have received from Messrs. H. Sotheran and Company, an interesting catalogue of books on Meteorology and Terrestrial Magnetism. This is a comprehensive list of books on the subject, dated from the year 1269 to 1910, and includes the works of such pioneers as Descartes, Gilbert, Boyle, and Dalton. Some of the early books appear but seldom in sale catalogues. In addition there is given a list of books on Aviation and of periodicals and publications of learned societies.

SECOND-HAND INSTRUMENTS.—We have received Mr. C. Baker's January list of second-hand instruments for sale or hire. It consists of ninety pages and from it many of our readers should be able to choose, at a reasonable cost, apparatus for which they might not care to pay the full and original price. This list deals with telescopes, microscopes, objectives, cameras, and lenses as well as less generally used apparatus.

WHITAKER'S ALMANAC.—We welcome the forty-fourth annual volume which has appeared under the title of "Whitaker's Almanac." As it is or should be on everyone's writing table, we can say nothing which will make those who know it appreciate it more, while to those who have not made use of it we can only offer our respectful sympathy.

ZADKIEL'S ALMANAC.—This contains matters of interest to our astronomical readers, though mainly devoted to the astrology and predictions which may be based upon it. Messrs. Simpkin, Marshall & Co. are the publishers.

THE YEAR-BOOK OF SCIENTIFIC AND LEARNED SOCIETIES.—This, though primarily a book of reference, is interesting to glance through, while the lists of lectures given before the various societies offer useful suggestions to officials of institutions, and to lecturers who are looking out for new subjects. It should be on the shelves of every library and public institution, and is published by Messrs. Charles Griffin & Company.

METALLURGICAL MICROSCOPES.—The microscopic examination of metals now forms such a very important branch of engineering industries that Messrs. R. and J. Beck, Limited, have brought out a special catalogue dealing with the examination and photographing of metals. The list also contains descriptions of cameras for taking photomicrographs, and machines for grinding and polishing sections. A special microscope is illustrated which has been designed for the examination of the surfaces of the various kinds of blocks used for printing with letterpress.

"WHO'S WHO" AND ITS COMPANIONS.—The editor of "Who's Who" continues each year to discover a number of new people who are playing an important part in the world, and as a result the annual volume which Messrs. A. & C. Black publish becomes larger and more useful, while its price remains the same. The "Who's Who" Year Book, containing matters of interest crowded out of the original volume, is still issued annually by the same firm, which publishes also, for writers and authors, another annual volume with the intention of helping those who are getting their living by contributing "copy" or illustrations to the periodical press. "The English Woman's" Year Book comes from the same source and contains much general information, as well as a great deal concerning education, occupation, and entertainment of special interest to the gentler sex.

SCIENCE REFERENCE BOOK AND DIARY FOR 1912.—Messrs. James Woolley, Sons & Co.'s Science Reference Book and Diary has again been revised. Not only does it consist of a diary, calendars for the past and coming years, a dictionary of daily wants, a lighting-up time table, and list of scientific societies, but it has a second part, with a different opening, which contains a reference book on all matters dealing with science, such as atomic weights, physical constants, and test solutions, while scientific terms are explained, and other matters considered of importance in the everyday life of scientific workers. The price is 1s. 6d., which is no greater than that of an ordinary diary got up in similar style.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

FEBRUARY, 1912.

THE GRAPHIC EXPRESSION OF SENSE.

By ANNA DEANE BUTCHER.

THE art of Typography has been, during the last twenty years, almost revolutionised. Entirely new processes have been invented, and it is claimed by the School of British Printing that it has made advances to an extent almost unparalleled in the recent history of any industry. Yet, with all these improvements in machinery and appliances, no similar ones have been made in the notation of the English language for four centuries, and we are confronted almost every hour of the day with the anomaly of a fifteenth-century print to express the complicated ideas, and define the accurate scientific conceptions, of the present day. Writing and printing as practised by civilised man are degenerate graphic arts, and while very much thought and money have been expended on mechanical precision, this most obvious fact has been overlooked, that if a drawing or symbol is unsuited to indicate sense or meaning, it is not only useless, but misleading, to ornament it or render it attractive to the eye.

It may be objected that "suitability" is a matter of opinion and taste, but this is not the case. The Ogee curve as assumed by the swan's neck is a beautiful because a suitable form: a walking-stick designed on this model would be a hideous object, because this form is wholly unsuitable to suggest strength or support. The laws of graphics or the expression of sense by the graphic arts are, like other physical laws, the ascertained causes of invariable phenomena.

It was the opinion of the late Professor Max Müller that until Language is studied as a physical, rather than an historical science, no practical improvement can take place in the means adopted by man for the expression of his thought or meaning.

The methods of investigation employed by the physicist are to accurately observe objects, to record facts and phenomena in their order of importance statistically, and then gradually, by the aid of the imagination, to guess a cause or invariable law which might account for the recurrence of these phenomena. He then proceeds to eliminate one after another those hypotheses which do *not* consistently explain the phenomena, until the true, or at least a workable law is discovered.

Following this scientific order we may deduce the following graphical laws.

Man is a silent-reading animal who draws his ideas. This definition of man is as true now as in the hieroglyphical age of the ancient Egyptians. Man has the power of communicating his ideas by speech, in common with many other animals, but as far as we know there exists no other creature who draws his ideas.

Therefore writing, or symbolism, is just as inevitably a natural product as the honey of the bee, the coral island, or the spider's web. Graphic symbolism is a function of the brain of man. Symbols control his actions, are photographed upon his brain, are associated with all his intellectual efforts, and from their influence he can by no means free himself.

Man has been from time immemorial a slave to the traditional symbols which he employs; he has no more power to change these symbols than a magpie has to alter the shape of its nest.

Notations grow like trees, in accordance with graphical, which are physical laws. The brain of man is developed, and its nervous telegraph apparatus is differentiated and taught to function, by the traditional symbols which surround him on all sides. But man is not aware of this slavery. The mathematician imagines himself free to construct theories, to develop his ideas at will, and to express them as he chooses, little thinking that he himself is a slave to traditional symbols and absolutely dependent upon a paper memory for his calculations, and that were it not for happy accidents of notations, mathematical science would not exist. The mechanical trick of placing two little horizontal straight lines one underneath the other suggested the idea of negative numbers, and is the origin of the Binomial Theorem.

All the absurd explanations of teachers and text-books are due to ignorance of the fact that the sign or mark precedes the idea. Sciences, Religious Philosophies, both false and true, owe their origin to symbols, yet no subject is so persistently disregarded as the natural history of man as a "symbol-drawing animal." The graphical expression of meaning is now no longer under the control and subject to the correction of the hand of man, but this function has been delegated to a number of mechanical contrivances, which are controlled automatically by mindless animate and inanimate forces *not* in harmony with the author of the idea. By the division of labour with the aid of these mechanical contrivances the daily progressive degeneration of the symbol goes on just in proportion as the machinery used is perfected. Thus the modern printer, with the assistance of the type-founder, covers the page with dots, tags, serifs, ornaments, finials, and marks of all description and in any situation, which are not intended to denote anything at all. The degeneration due to mechanical repetition can be traced back to the copyists of early manuscripts, who, not understanding the meaning of superscript marks, inserted them anywhere as ornaments to the script.

The stultifying effect of the machine upon the human intellect can be seen in that chapter of history which treats of the destruction of the symbol by the printer. Can anyone doubt, that had the expression of meaning remained under the control of the hand of the author, so indispensable a sign as one for accent or emphasis would, after the invention of many symbols to express it, and the survival of the fittest of them, be in universal use at the present day. The first Italian printers imitated the written characters, *i.e.*, the hand still dictated the shape of the letter; but the passion for mechanical uniformity which characterises common workmen of all ages, and more especially the printer of the present day, soon gave rise to the modification and distortion of the letters. As an example may be adduced the degeneration of the letter e in England. In Caxton's type this letter **e** was a straight-backed looped letter with a dot in the middle. It was called *ēe* and associated with the favourite vowel sound of the Anglo-Saxons, *i.e.*, the *i* sound in the word machine. But Caxton's types were clumsy, and not made with that mechanical accuracy which distinguished the Continental presses. It was therefore found convenient to discard these types and adopt the Roman characters, which were wholly foreign to the Gothic languages, and in many cases not suitable to express their sounds; thus the open round-backed *e* was adopted, which had on the Continent a definite phonetic association.

From the international misunderstanding resulting from this unfortunate substitution we have suffered up to the present day. The further degeneration of the type may be seen in the present fashionable letter e, which resembles a "nulla" or cypher crossed out, and has therefore been deprived of all character and power to express either sound or sense.

Signs of the revolt of the masses against the tyranny of the printer may be seen all over London on every hoarding, in every advertisement, and even in the tickets in the shop windows. All ignorant of the natural instinct which prompts him to rebel, the business man evinces his dissatisfaction with the monotonous, inexpressive, machine-made medium of intellectual communication which he orders from the printer, for which he pays so heavy a price, and which he is obliged to use whether it is suitable to his necessities or not.

The author thinks, the professor writes, the teacher teaches, the pupil copies, and the examiner records, exactly in the terms which the printer chooses to dictate.

The playwright must not instruct the actor as to what he wishes him to say, for the printer does not supply phonetic type.

Orators are requested *not* to be emphatic, for the printer does not choose to denote emphasis.

The singer has no guide to the pronunciation of his words, the traveller no help in foreign countries, the merchant no means of selling the goods which overstock the native market.

The foreigner has no key to the cypher in which the printer disguises the English literature, and what is termed "Elementary Education" is the explanation during three years of "Printers' Errors."

An article in Caslon's Calendar for 1887 contains a recognition of one of the printer's heresies. It is as follows:—

"The time has come when we are obliged in the face of demonstration to confess ourselves mistaken, affording one more instance of the folly of dogmatising on the possibilities of invention."

Let us take this recantation as an omen, foretelling the extinction of the present dumb, rule-of-thumb print, and the gradual introduction of a graphic system of expression based upon a geometrical key, which script may be translated into speech.

This new print will not be machine-made, but a product of the hand, eye, ear and voice, trained in unison, manufactured and supplied by the intelligence of the modern printer.

Wholesale reforms are very dangerous.

It is easy to destroy what cannot afterwards be restored.

Printing reform is loudly called for, but it must be founded on accurate knowledge of the associations which already exist between sign, sound and sense, and must not be the acceptation of any private cypher which any number of persons agree to adopt, where the signs chosen are *not* in accordance with natural law and traditional custom.

The following specimen of the Orthotype Notation, devised by the writer, illustrates the subject:—

THE RELIGION OF KNOWLEDGE.

An extract from "The Life of the Bee."

By MAETERLINCK.

"To discover the unconquerable duty of a living being is less difficult than one imagines: it is ever to be read in the distinguishing organs, whereto all the other organs are subordinate. And just as it is written in the tongue, the mouth, and the stomach of the bee that it must make honey, ... so in our eyes and ears and marrow, in every lobe of our brain, in every nerve of our body, it is written that we have been created in order to transform the forces we absorb from the earth into an energy of finer form and rarer quality. No other animal has thus been fashioned to produce this strange and subtle fluid, which we call thought, intelligence, understanding, reason, soul, spirit, cerebral force, virtue, goodness, justice, knowledge, for it has but one essence under a thousand names.

For the production of this essence all else has been sacrificed, ... our muscles, our health, the agility of our limbs, and the equilibrium of our functions: its growth endangers the very peace of our existence. This is the highest and most precious state to which matter or force can be raised. Flame, heat, light, nay life itself, and instinct more subtle than life and all the forces which ruled the world before our advent, have paled before its coming.

Let us not torment ourselves to know who will benefit by the energy which is accumulated at our expense. The bees know not if they shall eat the honey they have harvested . . . and we are equally ignorant as to who will profit by the spiritual energy which we are introducing into the universe.

As the bees go from flower to flower, collecting more honey than they or their offspring will ever need, let us go from reality to reality, seeking aliment for this incomprehensible flame . . . . . Let us nŏurish this ŝăcrɛd fire on our ŝɛntiments and păŝŝions, on ȧll wɕ ŝɕɕ or hɕar or tŏuch, on itŝ ȯwn ɛssence which is thɕ idëă it derives from the discȯveries, ɛxpërienćɛs, anɗ observȧtions which resŭlt from itŝ contact with thɕ ɛxtĕrnal wŏrld. A time will thɛn cŏme whɛn ȧll thiŋs will turn ŝȯ nȧtŭrally tσ gσσd, in a ŝpirit that has given itsɛlf tσ the lȯyal fulfilment of this ŝimple dȯty, that the vɛry ŝuspicion of the possible aimlɛssnɛss of itŝ ɛxhȧustiŋg ɛffort, will ȯnly rɛnder the dȯty the clɕarer, ... will ȯnly add mȯre pȯrity, power, diŝinterɛ́stɛdnɛss, and frɕɕdom, tσ thɕ ȃrdoŭr with which it still ŝɕɕks tσ "Knȯw".

^ [illegible] ´ [illegible] ` denotes a contracted diphthong [illegible]

) = aw	(= ɛ	˘ = u	¯ = σσ	' = o	^ = ah	˙ = i	¨ = ï
awe	hɛn	us	fσσd	on	ah!	in	marine
ȧll	ȧny	lŏve	prōve	wȧs	fȃr	bȯsy	machïne

The Phonetic [illegible] Phonographic Signs are [illegible] in the words given above

‿ = sh	s = z	ŝ = ss	c = ŝ	c k q = c k q		r = ur	ph = f
of = of	g = dj	ŋg = n	ɕ = ee	ɛ = e	a = ah	σ = oo	ch = tsh
rɕad = reed		rɛad = rɛd		tσ = twσ = tσσ	fȃr,	queɕn cat	kiŋg

The omission of the [illegible] in the [illegible] of i makes the letters (l, h, g, r) mute

The problem of International English is solved by the Orthotype Notation, which brings the phonetic element of the language up to date: that is, to the reign of Edward VII. It affords the printer an opportunity of taking his part in the education of his countrymen, and is the only answer hitherto offered to the question how to give the additional information necessary for the child and the foreigner, without destroying European idiography and without annoying the adult Englishman who knows, or thinks he knows, how to pronounce his own language.

Read with a pointer and hide the letters (a, e, i, o, u, y) below the Phonographic Signs ˘ ^ ( ) ¯ ^ ' ˙ ¨

The church wȧs a gɛm rŏugh and ȯld
Sɛt in jēwɛls ȧll grɕɕn ȯr of gȯld
Yσu cȃn't fail tσ sɕɕ how it stσσd
Fȃr awȧy at the side of the wσσd.

All the [illegible] sounds [illegible] language are heard and seen in these lines

The principle of printing reform is to associate the sound with part only of the letter, and if more than one letter is used to express one sound, a part must be chosen which is common to all of them, thus the dot on the right hand denotes the guttural sound of c, k, q.

An "Educational Print" in this form will serve as a standard for other styles of printing. The ordinary newspaper or journal whose end is the dustbin, the text book which serves a passing generation and expires in the second hand bookshop, may well be printed in the ordinary contracted form, but words like those of the great philosopher, Maeterlinck, classical literature, and all books which serve the purpose of copies for imitation by the child and the student, should be presented to the public in a form worthy of a scientific age.

THE NEW ASTRONOMY.

THE SUN.

By PROFESSOR A. W. BICKERTON.

The Approaching Solar Eclipses.

I did not intend to amplify my tentative views of the problems relating to the Sun and to Comets, as given in "The Birth of Worlds and Systems," but the phenomenal number of naked-eye comets in 1911 and the approaching eclipses of the Sun have caused a good deal of attention to be directed to the Sun and to Comets. At the meetings of the British Astronomical Association a number of papers have been read and questions asked regarding these two subjects. Many enquiries have also been addressed to me personally, and hence I think, as the physics of the third body seem to throw much light upon most of these questions, that an amplification of the suggestions made in my books regarding the physics of the Sun and Comets, will be of value. I shall not at present deal with the genesis of the Solar System, as I still believe that the Moons and Planets were captured, as I described in my papers in 1879 and 1880, and I have made no very exhaustive study of this part of the New Astronomy during the last few years.

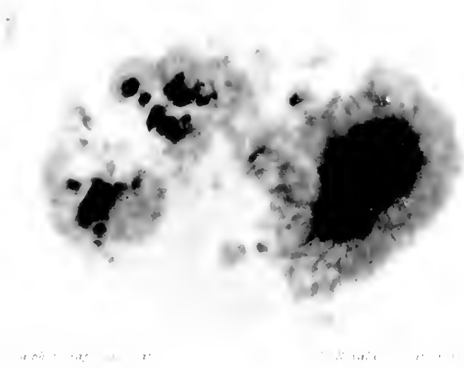


Figure 49. Sun Spots, July 31st, 1906.

In thus presenting a working hypothesis relating to the physics of the Sun and Comets, I wish it to be understood that these suggestions do not stand in line with the first four articles on the New Astronomy. Most of the matter of these articles consists of deductions absolutely demonstrated to be true by the indisputable nature of the observational evidence that has accumulated.

The Sun and its Surface.

The Sun, the ruling orb of the system of planets of which our Earth is a member, is a revolving blazing ball of fire, of such size and intensity, that, were its heat kept up by combustion, it would require to be stoked with six hundred times the coalfields of the entire Earth every minute of its existence.

The great globe on which we live takes us some two months to travel around it. It has a mass of some six thousand millions of millions of millions of tons. The vast solar furnace is more than a million times the size of the Earth. So intense is the internal heat and pressure of the Sun that the inner gases of which it is composed must be moving with such speed and under conditions that the molecular velocity must give its interior a dynamical rigidity of some thousand times that of the strongest nickel steel. Its surface temperature is something like 10,000° C.; so hot that the most intractable substance known on Earth would be fused and volatilized. The clouds of carbon that at one time were supposed to form its photosphere could no more exist in the solid form at the solar surface than could ice remain solid in a kitchen fire.

Surface Storms and Sun Spots.

The flames of this stupendous bonfire often leap upwards from its surface some scores of thousands of miles. On special occasions some of these vast tongues of fire have been seen towering above the limb of the Sun to a height of some hundreds of thousands of miles. Vast cyclones and other storms break into the general glow of its brilliant surface and produce dark spots; many of these sweeping whirlwinds of flame are so stupendous, that the great globe, our dwelling place, might drop into one of them with no more comparative effect than a chestnut in a cottage fire.

The Sun's Rotation.

In addition to these great flames and cyclonic storms, the Sun has many other characteristics that have been found hard to understand.

The Sun rotates in about thirty days, yet his equator completes a revolution in something like two days less than the parts some forty-five degrees of latitude away.

Thus a sliding action must be occurring among its gaseous constituents, adding greatly to the tumult of its surface.

THE PHOTOSPHERE [illegible] REVERSING LAYER [illegible]

The bright luminous part of the Sun [illegible] surface [illegible] called the photosphere. This is probably the [illegible] above it [illegible] supported. [illegible] is a thin band or sphere of metallic vapour, some [illegible] hundred miles thick. It is called the reversing layer [illegible] and appear to [illegible]

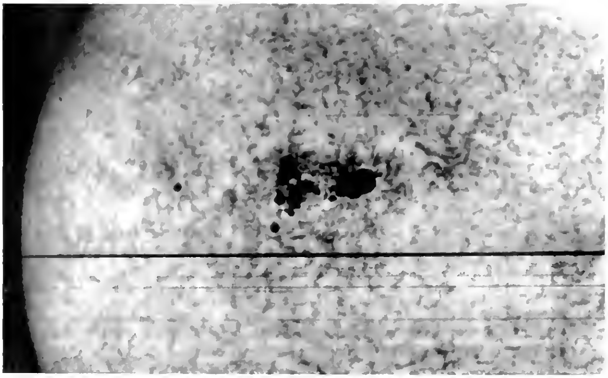


FIGURE 50. Iron Flocculi.

that produce the chief dark lines of the solar spectrum. Above this again is a still rarer layer of an atmosphere of hydrogen and other excessively light gases. This is called the chromosphere, because of its reddish colour. It appears to extend some thousands of miles above the Sun's surface.

In addition to the eight planets and their satellites and the belt of asteroids, a vast luminous, apparently a meteoric, glow surrounds the Sun in the plane of the ecliptic. It is called the Zodiacal light. It is probably so extensive as to reach beyond the orbit of the Earth; for when we look in a direction away from the sun on a clear dark night we see it in the form of a glow called the Gegenschein. These myriads of particles would in this position be seen lit up by sunshine as the moon is when at its full.

THE CORONA.

During a total eclipse, when for a few minutes the disc of the moon completely hides the face of the sun from view, not merely do we see the great red flames of glowing hydrogen and the vast volcanic ejections of blazing metals, but surrounding the black disc of the new moon are white shimmering radiant light, looking like a superb encircling [illegible]

[illegible] This [illegible] of the [illegible] power [illegible] controls the [illegible] that form the [illegible] of his mighty kingdom.

[illegible] the Sun. What are the forces, agencies, and [illegible] that control his speed of [illegible]; [illegible] produce his storms and tempests? What is the character of the mechanism that is the cause of his superb grandeur? What are the laws of nature laid under contribution to urge and regulate this seething mass of blazing gas? How can convection act to bring heat from the interior of a mass a thousand times as rigid as the strongest steel?

What pushing force can be at work urging the equatorial surface of gas to slide over and move faster than the general mass of the Sun? What originates the great solar storms and what motive power keeps for days and sometimes weeks, those tremendous tornadoes, sweeping the surface of that vast glowing furnace? What forces are at work keeping up the reversing layer and chromosphere? Why do they not collapse and sink down on to the Sun's static surface?

What are the agents that create the volcanoes that emit the vast red protuberances, and the still more wonderful metallic flames. What causes these tongues of fire, that leap upwards with velocities of hundreds of miles a second, sometimes towering to a height of hundreds of thousands of miles?

There are many other questions that face the solar student, and although some of them may not

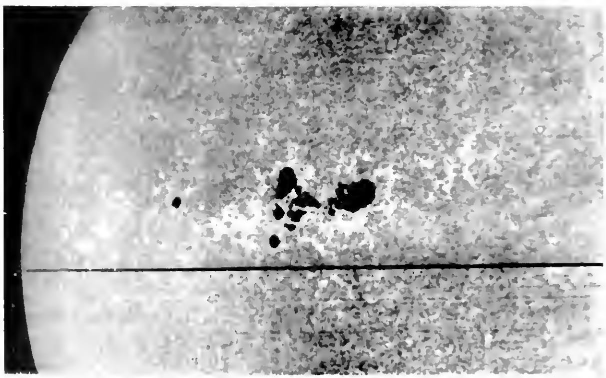


FIGURE 51. Hydrogen Flocculi.

in the present state of our knowledge be answered, all at least are capable of receiving intelligible suggestions of solution: suggestions that the diligent observers of solar phenomena may amplify, confirm or disprove.

The Coming Eclipse of the Sun.

The approaching eclipse is one that should be utilized to put many of these suggestions to the test. These physical inductions and deductions should be used as working hypotheses to tell what work should be done in the flying moments of that supreme astronomical event, the forthcoming total eclipse of the Sun. For we have to remember that, although our Sun is a very insignificant little Sun amidst the giant orbs we call the stars, he is hundreds of thousands of times the nearest star to the Earth, and hence possibly capable of suggesting information as to the physical constituents of the giant suns of the firmament even better than those distant orbs can tell us by their own atomic songs, as we read them in the rainbow-tinted streak, the cypher message of the wondrous story. Hence, the problem of the Sun is the supreme problem of the whole range of astro-physical research.

From a photograph taken at Chabot Observatory.

Figure 52. Solar Prominences.

How the Heat of the Sun is Kept Up.

There is very little doubt but Helmholtz's suggestion that the Sun's heat is kept up by compression is true. The fall of molecules is the dynamical source of the Sun's heat. The surface molecules radiate heat and lose speed, and the gravitating power of the Sun draws them nearer to his centre, and as they fall into this new position their speed increases. It becomes so much greater than it was before, that the entire temperature of the Sun gets higher. Thus we have the paradoxical fact that the Sun gets hotter the more heat it loses: that is, as long as it remains in the condition of free gas. It may be shown that a free gaseous sphere doubles its temperature when it is reduced to one half its diameter; that is, to eight times its original density. There is far more heat generated by this enormous compression than would double the temperature of the gas, but a large ratio is dissipated as radiant energy. The quantity of this ratio depends to some extent on the character of the molecules of the gas that is being acted upon. Almost certainly selective molecular escape is at work in all free gaseous masses, tending to sort the chemical elements so as to arrange them in such a manner that the heaviest are in the interior. The elements progressively lessen in atomic weight as we get further from the centre. At the surface itself we get the lightest of the elements, helium, hydrogen, nebulium, and so on.

Solar Storms and Volcanoes.

Looking upon the problem as one of gaseous dynamics, it would seem as though, were there no external agent acting upon a mass of gas, that the surface would be much more smooth and subject to much less tumult than we find on the surface of the Sun. Most of the strange behaviour of material on the solar surface seems to receive a solution if we look upon the Zodiacal light as a vast meteoric appendage to the Sun, meteoric particles whose angular velocity is too great to allow them to be absorbed with the general shrinking gaseous material that forms the Sun himself. I do not propose now to give an account of my idea of the origin of the Sun and the solar system, other than to state that I look upon the collision that formed the Sun as almost a direct one, and that the whole of the bodies that revolve about the Sun were material that did not come into impact. They extended beyond the region of actual collision and whirled around at such a velocity as to be able to balance themselves in

From a photograph Figure 53. *by E. E. Barnard.*

The Corona, as seen in the total Solar Eclipse of May 28th, 1900.

orbit. The [illegible] mated the planets, the selective action upon particles and meteoric matter that would produce [illegible] somewhat similar to the solar system, I have already discussed in some detail in the "Romance of the Heavens," in papers published in the "Transactions of the New Zealand Institute" and elsewhere.

The Energy of Meteors.

We will simply assume that the Zodiacal light consists of myriad millions of free meteoric particles, each revolving around the Sun in an independent orbit. Many of the orbits would be highly elliptical, and any particle that reached the surface of the Sun would do so with a velocity of the order of three hundred miles a second. It is extremely possible that in various ways these colliding meteors would act in the same way upon the inherent energy of the Sun as detonating caps act upon a mass of high explosives.

A particle striking the Sun with a velocity of three hundred miles a second would be possessed of an energy equal to at least a score of thousands of times its mass of dynamite. According to the angle they would strike the Sun, there would be considerable variation in the result. The great majority would strike the Sun tangentially in the direction of the Sun's own motion. From the distribution of the Zodiacal light it is clear that the orbit of such particles as struck very tangentially would mainly be near the equator of the Sun, but as the plane of the solar equator differs by several degrees from the plane of the ecliptic, it would seem to deviate from that of the Zodiacal light, and impact would not be confined to the equator.

The Sun's Differential Rotation.

Every ton of such material would have an urging power upon the gaseous photosphere of the Sun, urging it forward with a pressure of over twenty thousand tons of exploding dynamite. It is also obvious that this effect will tell most upon the higher strata of the solar atmosphere, and that the differential velocity would consequently be greatest in the highest regions, and may account for the apparent fact that solar storms become more cyclonic the higher the region from which the photograph is taken. (See Figure 51.) Thus many of the anomalies of the Sun's differential rate of rotation seem to find a solution, if we consider the tremendous meteoric bombardment to which the equatorial regions are subject. It must be understood that it is not the equatorial rotation which is kept up by meteoric bombardment: it is merely the differential rate.

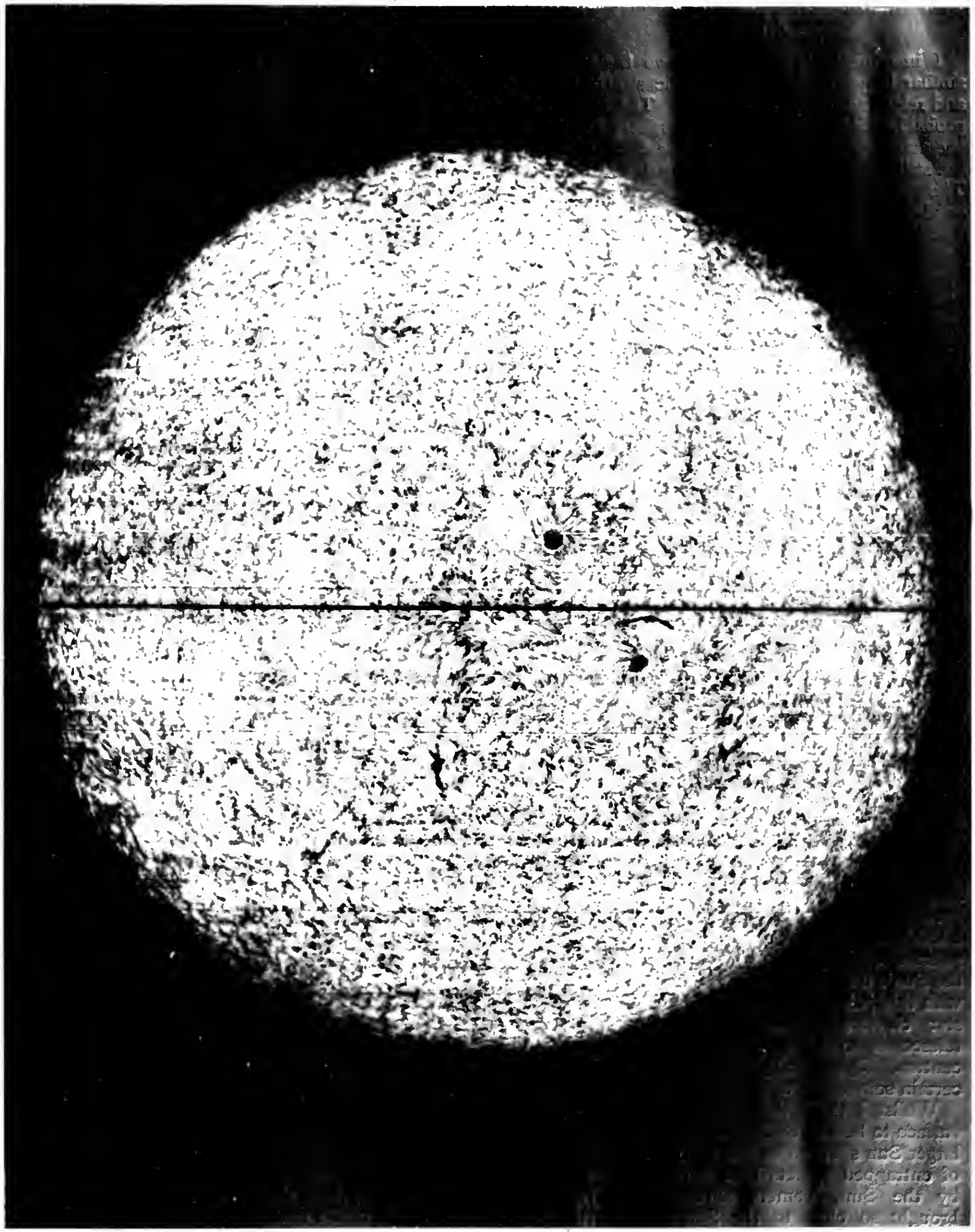
The Red Protuberances.

A meteor of moderate dimensions with a velocity of three hundred miles a second would develop heat sufficient to become completely volatilized at great heights in the solar chromosphere. It is a property of a mass of gas in motion to cause adjacent gas to acquire a motion also. This gaseous adhesion would entangle an immense quantity of the hydrogen of the chromosphere, and carry it down with it into the body of the Sun. As it would still retain an enormous velocity when it struck the surface of the photosphere, it would plunge to some depth below the surface, pressing the gases of the photosphere before it, and increasing their pressure so enormously, that when the velocity had spent itself an explosive reaction would occur, and the compressed gases of the photosphere would act as a violent explosive and blow the hydrogen that the volatilized meteor had brought with it to a vast height. Practically a volcano would be formed in the photosphere. (See Figure 52.) Sometimes the chief strength of this volcano would expend itself in blowing out vast flames of hydrogen, and the character of these flames would clearly depend to a large extent on the area of the disturbance, and on the angle at which the material was driven in on to the surface of the Sun. The strength of the explosion would be enormously greater than the energy possessed by the meteor itself, because the exploding volcano would produce a release of pressure from that portion of the Sun, and the extraordinary temperatures and pressure of these lower depths would exert themselves in carrying up a great deal more material than had been compressed.

In considering the effects of solar volcanoes we must remember that the great rigidity of the Sun is not a cohesion rigidity such as steel, but a dynamical rigidity, a rigidity of velocity, such as high-speed water, or a rapidly revolving chain in the form of a hoop, which will roll along the road exactly as though it were a hoop of spring steel.

Solar Meteors.

It is almost certain that large meteoric masses strike the Sun as they do the Earth. Brilliant flashes have been seen on the solar surface. These are often accompanied by magnetic storms and aurorae on the Earth. It is probable also that, unless the mass were gigantic, solar meteors would be largely volatilized before striking, and hence produce a broad field of impact. The ensuing explosion would eject it by pressure, and be followed by material from below, and this would again liberate lower material, until the opening would be so deep as to bring up metals of considerable atomic weight. The very factor of dynamical rigidity, that would tend to prevent ordinary convection currents, would actually be the agent in producing them when the downward-acting pressure was removed. At the same time this molecular motion would produce a lateral inrush that would tend to prevent the uprush extending to great depths, except in the case of the bombarding meteors being of very large mass, or a dense meteoric swarm. Such large impacts are probably the cause of the metallic ejections that sometimes reach hundreds of thousands of miles. The various angles of slope of the stream of material is probably due to different angles of impact.



[illegible]

[illegible] Sun [illegible] Vortices rotating [illegible] opposite directions [illegible]

SUN SPOTS.

I imagine that Sun spots [illegible] their [illegible] similar large meteors or meteoric swarms colliding and [illegible] the [illegible] The spot itself is probably the [illegible] photosphere that follows the actual [illegible] the dark spots, which are still [illegible] being due to expansion. The [illegible] probably remains in its position on the [illegible] travels on the surface. The [illegible] luminous masses are probably [illegible] compression. Perhaps the [illegible] hot [illegible] from the interior would also be more luminous than that which has expanded, cooled and is descending.

Spots are often associated together, sometimes

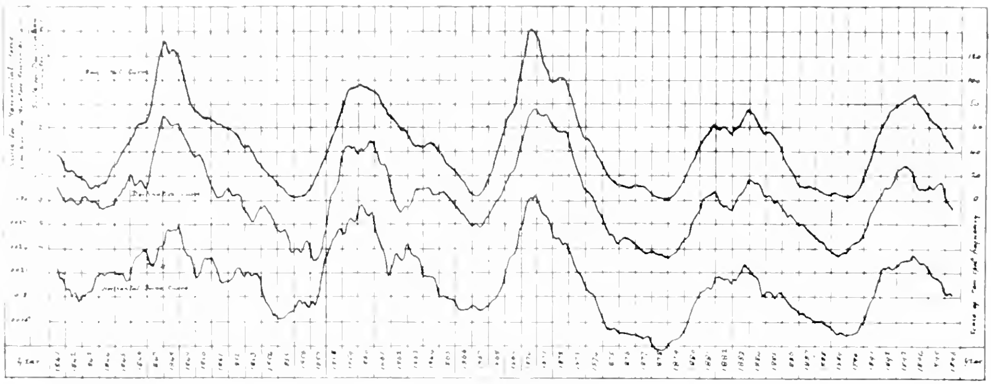


FIGURE 55.

Smoothed Curves of Sun Spot Frequency (Wolf), compared with corresponding curves, showing the Variation in Diurnal Range of the Magnetic Elements of Declination and Horizontal Force, from Observations made at the Royal Observatory, Greenwich.

long ranks appear at once. This may be due to bursting meteors, as we see them burst in the Earth's atmosphere, or they may be due to meteoric swarms with subordinate nuclei, breaking up under the Sun's differential tidal attraction. In connection with this point, photographs of comets' nuclei and of star clusters should be taken with very large telescopes to bring out and detect subordinate centres. Dynamically such subordinate centres seem certain sometimes to form in many swarms.

Whilst I think the general mottling of the Sun's surface to be due to Zodiacal meteors, I believe the larger Sun spots to be due to meteors that are parts of entrapped comets that have been torn to pieces by the Sun, comets entrapped by Jupiter and brought so close to the Sun as to partly impact. Schuster's investigations seem to me to point to the fact that more than one, perhaps many, comets have been so entrapped. The great eleven-year period suggests that a very large cometic swarm narrowly escaped complete impact and so became a forked stable meteoric swarm. However, I do not want to give too much prominence to this tentative suggestion. I have discussed the idea in some detail in "The Birth of Worlds and Systems" in "Harper's Library of Living Thought."

THE SUN'S LAYERS.

We have still to offer suggestions of explanations of the four ensphering luminous atmospheres of the Sun. The photosphere, the reversing layer, the chromosphere and the corona.

The idea that the photosphere is a carbon cloud formation, although very beautiful and a remarkably logical scientific induction, is probably not true, as the absolute temperature of the Sun's photosphere is almost certainly twice as high as that at which sublimed carbon can exist. I believe this intensely luminous envelope to be the surface of aerostatic pressure. The gravitation energy of the Sun, about twenty-eight times that of the Earth, must double the density of the surface gas at a very small depth. What this depth is it would be difficult to say, because temperature must increase enormously as well as pressure. The thermodynamics of the problem is very complex. I strongly suggest that, before trying to master this very popular account, students shall read the short statement of the dynamical theory of gases, and the contrast of gaseous pressure and kinetol as given on pages 106 to 109 in "The Birth of Worlds and Systems."

I take it, then, that the photosphere is the limit area of statical support. I shall try to show that all above this surface is dynamically supported, and does not follow the statical laws of the dynamical theory of gases as to pressure and volume. These layers are probably in rapid motion, and are supported by their high kinetol.

Although atom-sorting or selective molecular escape must always be acting, yet in such a seething mass as the Sun there would be mixing currents continuously acting; these would tend to bring the heavier elements to the solar surface. Yet the centre of every free mixed gaseous sphere will ever consist of elements heavier than the surface.

If we consider the photosphere to be the exterior limit of statically-supported mixed gases, and were the temperature to remain constant, the gases would double their density by pressure in one-eighth of a mile. That is, at a depth of a mile it would be two hundred and fifty-six times the density of the surface. Clearly, no matter how rapid the increase of heat, the statical surface of mixed gas would be quite definite. Were there no meteoric bombardment the surface would possibly be much smoother, and the dynamical rigidity of the Sun would largely prevent convection currents. Thus, the Sun would cool much more slowly than it does as it is. It would also last much longer. The detonating action of bombarding meteors, as it were, pokes the fire and makes it burn much more fiercely and causes it to give off much greater radiation.

The photosphere is consequently the very brilliant surface of solar equilibrium disturbed and rendered brilliant by convection currents due to impacts; the molecular speed of its dynamical rigidity being used to produce convection currents that bring the internal heat, produced by continuous compression, to the surface.

The Reversing Layer.

This is largely mixed metallic vapours and gas probably projected upwards by convection volcanoes, chiefly produced by the small meteors of the Zodiacal light, aided also by the violent ejections produced by cometic meteors.

The reversing layer is about six hundred miles thick. Such thickness, if aerostatically supported, would acquire in its lower layer an inconceivable density. Yet it would appear its density is not many times greater in its greatest depths than it is near its exterior surface.

A mean velocity of ejection of ten miles a second would be amply sufficient to give a dynamical supporting power of six hundred miles.

It is probable that the chief absorption that produces the reversed lines of the solar spectrum lies mainly at the outer surface, where the mean velocity would be small. All the time the convection tongues were rising the lighter gases would be escaping from them; but practically all the mixed elements of the flame would reach the height the flame would be carried to by its velocity. Thus the apparent levitation of the reversing layer is the high kinetol it possesses in its emergence from the photosphere.

It is extremely probable that the bombardment of escaping electrons and radioactive emissions may help also to support the layers of the Sun outside the photosphere. It may also be aided by the pressure of light.

The Chromosphere.

The surface of the reversing layer is the outer region of the mixed kinetol. Atom-sorting has been acting on its outer surface, and the high kinetol of the light elements will cause them to escape. These gases are the chromosphere. It seems to be chiefly hydrogen. The mean kinetol of this gas, as calculated, is four times that of helium, if both are in the monatomic state. Yet this is not necessarily true, for both helium and calcium are abnormal elements. They almost certainly dissociate into fragments; the evidence that calcium does so is very great indeed. And it is probable that these proto-elements, as Lockyer calls them, give especial spectra.

The chromosphere has a thickness of four or five thousand miles. Clearly it is dynamically supported. It is almost certainly supported by the high kinetol of these light elements or proto-elements.

I think that what is called the dusky veil is probably condensed material that has travelled to great heights and has radiated its heat, and temporarily assumed a cloudy form.

Review of Layers.

Thus, the photosphere is the natural statical surface of the Sun broken into rice-grain faculae, spots, and so on, by the detonation action of meteoric bombardment, these impacts liberating in turn the solar energy. The reversing layer is an ensphering shell of material carried up by the kinetol of these convection currents.

The chromosphere is light gas tinted with hydrogen, and supported by the high kinetol that light gases possess, compared with heavy gas at the same temperature.

The Corona.

The glorious radiation halo (see Figure 53) that shows itself as surrounding the Sun during a total eclipse is probably an electrical phenomenon, as I believe the tails of comets and the aurora also to be radiant beams induced by the electricity developed by the friction of the volcanoes of impacts and the convection currents so produced.

This induced electricity, acting on cosmic dust, lights it up. The character of the corona alters so regularly with Sun spot frequency as to leave no doubt the two are connected. Something like forty years ago, I published a paper in *The Philosophical Magazine* on a new relation between heat and electricity, that led me to the conclusion that the Sun is an electrified body. The disturbance of this by volcanic friction, I imagine to be the cause of the corona.

Sun Spots and Terrestrial Magnetism.

Terrestrial magnetism is probably due to induced currents of electricity produced by the Earth's rotation acting on solar induction. This is a constant action that is slightly increased or lessened by the ation of Sun-spots, and by the friction producing the flashes of light seen on the solar surface.

The coincidences of these two variables is very striking as shown by the accompanying diagram (Figure 55). Clearly it is conclusively proven. Earth auroras are also associated with the same phenomena.

CONCLUSION.

The Sun presents too stupendous a series of problems to be effectively dealt with in a single article. The foregoing ideas are offered as preliminary suggestions for the solution of some of them. Sufficient has been said to show the complexity, the wonder and beauty of the subject, and also its basic importance. Magnificent work is now being done by workers in many fertile fields of its varied researches. Some are taking photographs in special wave-lengths of varied elements, chiefly calcium and hydrogen. It will be seen by the accompanying pictures what wonderful information they afford of the ensphering solar surfaces. How clearly they show the cyclonic increase with altitude. We want all the information we can get. And the proposed solar observatory for Australasia should soon be a realized fact. For the wondrous skies of the Antipodes are singularly suitable, and the Sun is there showing his brightest when night reigns in England.

I hope that those about to be engaged in work connected with the coming eclipses will see if any of the above suggestions may serve as working hypotheses to guide their important researches.

In the next article I shall give some tentative ideas regarding the character of Comets.

THE TINTS AND SHADES OF AUTUMN WOODS.

By P. Q. KEEGAN, LL.D.

SEVERAL views, hypotheses, or opinions, based on experimental research, or otherwise, have been broached regarding the origin or production of the red, yellow and brown tints and shades exhibited by our forest leaves in autumn. The question stands next in interest, perhaps, to the cognate one as to the origin of the floral pigments, and, like the latter, it can be elucidated only by a consideration of the chemical facts which lead to an understanding of the physiological processes involved. That there is some intimate connection between the actual condition of vitality of the leaf at the autumnal period, and the particular tint or shade which it will then exhibit, can, I think, be fully demonstrated. There are, fortunately, two indisputable tests or indications detectable by chemical analysis which assure us to a certainty as respects this condition of vegetative activity. In the first place, we may compare the relative proportions of the special ministers of protoplasmic activity, viz., the albuminoids, in summer and in autumn; and secondly, by comparing the relative quantities of certain of the mineral matters (ash) present therein at the two stated periods respectively. Let it be observed at once that when the percentage proportion of albuminoid found in the autumn leaf is considerably less than that found in a similar leaf in summer, the conclusion may be drawn that the vitality thereof is sustained up till a late period; and when the case is reversed the inference is that there has been an early exhaustion of the vegetative activity. In other words, in the former case the albuminoids are mostly used up, and in the latter case they remain stored up in some inactive form or other. Similarly, also, with respect to the silica in the ash; an autumn leaf containing little silica is still alive, as it were, and *vice versa*. The following table is given in illustration of these facts:

LEAVES RED IN AUTUMN.

	Albuminoids in Summer.	Albuminoids in Autumn.	Per cent. of Silica in the Autumn Ash.
Wild Cherry	6·7	0·76	3·3
Rowan	11·3	3·4	3·4
Birch	11	6·1	6·9
Elder	14·7	8·8	4·5
Pear	14·5	7	6
Scarlet Oak	14·4	7	4·3

LEAVES YELLOW OR BROWN IN AUTUMN.

Sycamore	20·3	20	20·7
Spanish Chestnut	14·6	11	15
Hazel	17·3	16	11·6
Elm	17·9	16	28·8
Horse Chestnut	13·8	10	15·7
Black Poplar	17·3	14·3	10

The figures represent the percentages of albuminoid in the dried leaf.

It may also be noted that, in certain years and localities, oaks and beeches exhibit a very decent show of red, while, at the same time, the percentage of albuminoid falls below the normal, although that of silica may still remain pretty high, but in these instances the quantity of total ash is always low (about six per cent. in dry). Nevertheless, on a general review of the phenomena, it appears certain that where the protoplasmic albuminoid remains active till late, *i.e.*, in a more or less labile and soluble condition, the encroachment of silica upon the foliar tissues is checked, and the leaf assumes a bright red tint. The physiological processes are still vigorously sustained, and the cells retain both their water and their volume; but deassimilation predominates over assimilation, and hence there is more oxidation than reduction, more analysis than synthesis, a destruction of chlorophyll and a depletion of starch, a powerful accumulation of saccharine matters and glucosides; and finally, an especially strong and distinctive appearance of that crowning product of the foliar laboratory, named erythrophyll.

(*To be continued.*)

MEDICINES: ANCIENT AND MODERN.

By OLIVER C. M. DAVIS, D.Sc.

Lecturer in Materia Medica in the University of Bristol.

THE past fifty years has witnessed a very great activity among investigators in every branch of science, and the results of countless workers have been made use of for various purposes: it is highly probable that no art has gained such valuable knowledge through experimental research as that of medicine, which has been raised from gross empiricism to the proud position it now occupies. This satisfactory state of things has been brought about not only by direct chemical observations made by medical practitioners, but also by the chemist, physiologist, and bacteriologist in their respective laboratories. In early Egyptian times the practice of medicine lay in the hands of the priests, and was a sacred art surrounded by mysticism and superstition: it was then customary to use amulets (some of which were worn during life, and buried with the dead) and other charms as preventives of various forms of disease forerunners of a scientific scheme of prophylactic medicine. (Figures 56–58).

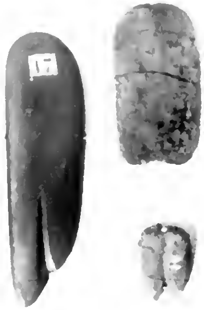


FIGURE 56.

Amulets of the two fingers.

FIGURE 57.

Tet Amulets.

FIGURE 58.

Papyrus Sceptre Amulets.

The preparations for internal use up to the end of the fifteenth century consisted very largely of vegetable substances, and were chiefly characterized by the vast number of the ingredients which composed them: towards the end of that century Basil Valentine attempted to employ chemical substances in medicine, and actually recommended the use of antimony for fever (Malaria), and other diseases which we now term protozoic. The use of antimony has lately been recommended by Plimmer (1906). Shortly after, Paracelsus boldly stated that the object of the chemist was to prepare medicine, and not make gold—which was an alchemistic idea.

One of the first pharmacopoeias sanctioned by civil government was published at Nurnberg in 1545; it was largely based on the work of Galen, and some of the preparations therein contained are still in use. The first edition of the Pharmacopoeia Londinensis (1618), mentions one item, "Cranium humanum violente morte extinctum," which is sufficient to demonstrate that the apothecary's art was then surrounded by a veil of superstition: in the same edition was included the Theriaca of Mithridates which contained about two hundred and fifty ingredients. A most instructive and interesting contemporary work is "Burton's Anatomy of Melancholy," which in addition to mentioning all sorts of oils, liniments, plasters, and cerates, also sets forth the virtues of "sacks, bags, odoraments, and posies."

From this period, right down to comparatively recent times, an examination of medical works shows very clearly the absolutely empirical and unsystematic way in which medicines were compounded and administered: this is readily accounted for when we remember in the first place that the knowledge of the constituents of vegetable drugs was extremely vague and unsatisfactory; secondly, that reliable information regarding the action of drugs and their fate within the organism was almost entirely lacking, and last, but by no means least, the underlying cause of disease was seldom known. It is due to researches in these directions that our knowledge of the constitution of drugs and their physiological action has been progressing with a remarkable rapidity during late years.

In the chemical laboratory it has been shown that, Under suitable treatment, natural products such as leaves, roots and barks can be made to yield definite chemical compounds, among which are the alkaloids and glucosides; these have in many cases been very fully investigated both from the point of view of their chemical structure and their action on living organisms. Figure 59 shows six natural products from which powerful alkaloids are extracted: Aconite root and Calabar beans (obtained from West Coast of Africa) respectively contain aconitine and physostigmine, quinine exists in Cinchona bark, cocaine in Coca leaves, ergotinine in Ergot, and Nux-Vomica gives rise to the well-known substance strychnine. The vast strides in organic chemistry have also enabled the chemist to synthesise large numbers of compounds possessing a known structure and a known action—which action can frequently be modified by a modification of structure: these synthetic compounds have, after investigation, been classified according to their action as antipyretics, antiseptics, diuretics, hypnotics, and so on.

FIGURE 59.

1. Aconite Root.
2. Calabar Beans.
3. Cinchona Bark.
4. Coca Leaves.
5. Ergot.
6. Nux Vomica Seeds.

At the present time, therefore, instead of administering to his patient large quantities of indefinite and uncertain preparations containing numerous ingredients which may be chemically or physiologically antagonistic to each other, the physician is enabled to select some definite compound regarding which he knows both the chemical constitution and the physiological action: by subsequent observation of the patient he can ascertain whether the drug is acting in a satisfactory manner, and, if not, administer one of a different chemical constitution; but under the old conditions of "polypharmacy" it was a virtual impossibility to attribute the harmful or beneficial action of a preparation to any special ingredient.

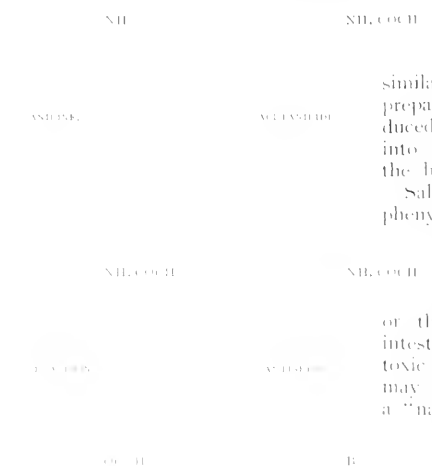


FIGURE 60.

As an illustration of the possibility of modifying the action of a chemical compound, the case of aniline and certain of its derivatives may be taken.

Aniline, which has very marked physiological action, owes its activity largely to the presence of the benzene nucleus, and the view may be held that the "amino" group (NH_2) serves as an "anchoring group," and thus brings the molecule into contact with the protoplasm. It is far too toxic for satisfactory application as a drug, but by replacing one of the hydrogen atoms of the amino group by the "acetyl" radicle ($COCH_3$) we obtain a substance known as Acetanilide, or Antifebrin. This is very slowly hydrolysed within the organism, with gradual elimination of small quantities of aniline, which becomes oxidized in the body to para-amino-phenol, to which the physiological action is partly due, and may thus be used with a reasonable amount of safety as an antipyretic: the formulae in Figure 60 show very clearly how the molecule of aniline may be modified in this and other directions to give rise to medicinal products of varying structure and activity.

It is obvious that without a definite knowledge of the fate of a compound within the organism it would be quite impossible to modify the action of aniline as above described by administering it in the form of various derivatives. In a somewhat similar way, other synthetic preparations have been introduced, which are decomposed into definite products within the body.

Salol, for example, is the phenyl ester of Salicylic Acid, and in presence of the alkaline juices of the duodenum gives rise to salicylic acid and phenol or their salts, which act as intestinal disinfectants; a less toxic product, β Naphthol, may be similarly liberated in a "nascent" condition in the duodenum by employing the β Naphthyl Ester of Salicylic Acid, which is known as Betol.

Another drug of the same type largely and successfully employed, under different names, is Acetyl-Salicylic-Acid, which gives rise internally to Acetic and Salicylic Acids; such examples as this make it obvious that the action of a drug may frequently be foretold by investigating its decomposition products and stability in the chemical laboratory. Whereas Acetanilide, as previously mentioned, has found an application in practical medicine, two compounds belonging to the same class, namely Formanilide and Benzanilide are quite useless, since the former is far too readily acted upon by reagents, and the latter under similar conditions is not appreciably broken down into reactive products. It has been shown by numerous workers that the stereo-configuration of an organic compound, *i.e.*, the spatial arrangement of the component atoms and groups may exert a profound influence on its chemical properties; thus the "ortho" and "para" toluidines (which differ only in the space relationship between the two substituent groups in the benzene ring), behave quite differently towards reagents, the former compound being the less reactive of the two; corresponding with this difference in chemical properties, the toxicity of the "para" compound is approximately twice as great as that of the "ortho" derivative. An important example of this phenomenon will be dealt with subsequently, when the treatment of sleeping sickness is discussed.

Figure 61.

Trypanosomes in Blood.

Photographed from an excellent drawing made from an actual specimen.

This increasing use of isolated active principles and definite chemical compounds in place of preparations of uncertain strength and indefinite action, is well demonstrated by a comparative study of the three editions of the British Pharmacopoeia, when it will be noticed that many of the old-fashioned concoctions are being gradually replaced by those which are rational and scientific in their composition. As an example we may take two classes of preparation typical of the old conditions of pharmacy, confections (electuaries) and decoctions: the former are semi-solid medicaments consisting of various drugs, chiefly of vegetable origin, mixed together with sweetening agents, such as honey, and the latter are made by boiling barks, roots, and so on, with water.

The 1864 Pharmacopoeia includes seven confections and thirteen decoctions; the 1885 edition, a much larger work, includes eight confections and thirteen decoctions, and the latest edition, published in 1895, mentions only four confections and three decoctions. In place of such as these there has been an introduction of increasing numbers of definite chemical substances into official pharmaceutical works; several such preparations, e.g., certain alkaloids, ether, and chloroform, found a place in the first British Pharmacopoeia, and the last edition contains details regarding a number of synthetic compounds, among which may be mentioned Acetanilide, Phenazone, Salol, and Sulphonal.

Apart from the great advances in Pharmacology brought about by the researches of chemists and physiologists, there has been a distinctly forward movement on the part of pharmacists to place within the reach of medical practitioners galenical preparations of undoubted quality, strength and elegance, and this advance is largely due to the British Pharmaceutical Conference.

In the first edition of the British Pharmacopoeia, previously referred to, many tests are given for impurities in inorganic chemicals, but very few standards are set for drugs of organic origin; in the second edition there is a distinct improvement in this direction, which is maintained in a striking manner in the latest edition, in which directions are given for the accurate standardization of a considerable number of tinctures and extracts—such as those of nux-vomica, opium, belladonna and ipecacuanha, which contain as their active principles poisonous alkaloids. In one special case—nux-vomica—the preparations are adjusted to contain a definite percentage of strychnine instead of total alkaloids, since it has been found that this alkaloid is far more toxic and active than those with which it is associated. In cases where no official standard is set, various workers have described satisfactory methods for obtaining uniform standards, which are adopted by the leading manufacturing chemists. While methods of chemical standardization are very desirable, yet, in some instances, they are not quite satisfactory, and in such cases physiological methods are used; this applies more especially to those preparations derived from digitalis, ergot, and strophanthus, where an inactive drug might be responsible for most serious results. All this valuable information with regard to the structure and pharmacology of drugs would be of little use in practical medicine but for the great accumulation of knowledge regarding the cause of many diseases. In this direction Lord Lister, Pasteur and Koch have done pioneer work in proving conclusively that definite diseases are frequently associated with definite micro-organisms termed bacteria or bacilli, which must be exterminated to effect a cure. It

[It has] also been shown that certain diseases are caused by a [parasitic] species of micro-organism known as protozoa, which find their way by various means into the blood of human beings or animals and bring about pathological conditions. Drugs which act by destroying such micro-organisms are known as "specifics," and to this class belong quinine, arsenic, antimony, and mercury. Quinine, the specific for malarial fever, was introduced to European pharmaceutics soon after the discovery of Peru, and has been generally recommended since the successful treatment of the Countess Cinchon (1640), hence the name, "Cinchona," of the tree from which the drug is extracted. Of very great medical importance is arsenic, especially those organic compounds which contain this element. An arsenic compound known as "Atoxyl" has been successfully used in the treatment of sleeping sickness. It is chemically known as Para-amino-phenyl-arsenic acid, and is represented by the constitutional formula. (See Figure 62.)

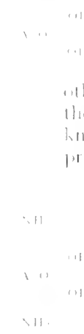


FIGURE 62.

The isomeric "ortho" compound has no effect on the [sleeping sickness] parasites (Trypanosomes); these are shown in Figure 61, in which they are seen in the form of elongated flagellated structures between red and white blood corpuscles.

The elaborate investigations of Ehrlich, Bertheim, Nierenstein and others on the action of atoxyl have led to the discovery of Salvarsan, commonly known as "606," which it is hoped may prove a specific for syphilis.

Mercury and antimony have a similar "specific" action, and the effects of some of the aniline dyes are very interesting, one of which, Methylene Blue, is used in the treatment of Malaria, in cases where the protozoa have been refractory to quinine.

It is to be hoped that as scientific research proceeds other specifics will be introduced into the practice of medicine.

My thanks are due to Mr. J. Quick, curator of the Bristol Art Gallery, for permission to photograph the amulets which are in his care.

THE ASTRONOMICAL SOCIETY OF BARCELONA.

A GENEROUS DONOR.

FORTHCOMING LUNAR EXHIBITION.

SINCE receiving the Royal favour a year ago this Society has considerably increased in numbers. The roll now contains four hundred names, and the Society is entering upon its second winter season with very rosy prospects. One of the objects of the Society, upon which special stress was laid at its foundation in January, 1910, was the provision of a public observatory where members might meet on fine evenings to study celestial phenomena, and to discuss points of astronomical interest. This, indeed, is the primary object of most societies of this nature, but it is seldom that it is realised. In the case of the Barcelona Society, as a matter of fact, although a reserve fund was accumulating with considerable rapidity, it was felt that it would be a very long time before the Society could acquire a suitable observatory. It is pleasant to record, however, that the primary object of the promoters has been realised very unexpectedly, and without cost to the Society, in such a manner that within the next few weeks the members will be in absolute possession of a well-equipped observatory.

Señor Rafael Patxot y Jubert, one of Spain's illustrious men of science, and a foundation member of the Society, has been so greatly impressed by the valuable work which is being carried on that he has offered to present his observatory and instruments to the Society, and, needless to say, the offer has been eagerly accepted. This establishment, "The Observatori Català," is situated at San Feliu de Guixols, in the province of Gerona, and in importance stands next to the observatories of Madrid and San Fernando. It has accomplished much valuable astrophysical work under the directorship of its owner during the past ten years, chiefly in the direction of the measurement of multiple stars. The whole establishment will be removed immediately to Barcelona, where it will be re-erected on the roof of one of the public buildings in a position easy of access to all members of the Society.

The dome, which is constructed of steel, has an internal diameter of seventeen feet, and was made by Messrs. Gilon, of Paris. It covers a fine double equatorial by Mailhat, visual and photographic, with apertures of eight and three-quarter inches, and focal lengths of ten feet and seven feet nine inches respectively. A complete set of accessories of precision is included in the gift, spectroscope, micrometer, camera, electric pendulum, and azimuthal theodolite. Annexed to the observatory in its new position will be a room for meetings of the Society, library, photographic laboratory, and so on. The Society realises that the best way to thank so generous a donor as Señor Patxot is to prove to him that his gift is appreciated to the fullest extent, and therefore one may confidently look for great things from Barcelona in the early future. One cannot speak too highly of disinterested generosity such as this, and whilst congratulating the Society on its good luck, one must also congratulate the donor, not only on his beneficence, but on his wisdom in choosing so deserving a body upon which to exercise his generosity. The value of the gift must not be expressed in terms of £ s. d., but must be reckoned by the amount of pleasure and instruction which it will afford to the thousands of people who will be privileged to use the instruments henceforward.

Preparations for the public Lunar Exhibition which will be held in Barcelona in May, 1912, are being pushed forward rapidly, and already many promises of assistance have been received from all parts of the world. The following gentlemen have accepted invitations to serve upon the honorary Executive Committee: Messrs. Flammarion, Pickering, Frost, Campbell, Aitken, Hale, Ritchey, Antoniadi, Bailland, Puiseux, Goodacre, Cerulli, Bolton, Discilligny, de Alcarate, R. P. Cirera, Ricart y Giralt, Stroobant, and Weinek. The success of the Exhibition, therefore, seems assured. Among the [illegible] already announced, the Lick Observatory [illegible] to send a set of twenty sheets of the great photographic Lunar Atlas obtained by means of the thirty-six inch refractor between 1890 and 1895, together with a collection of the [illegible] on a large scale specially intended for exhibition in various countries. M. Puiseux has intimated that the Paris Observatory will be pleased to exhibit a copy of the Lunar Atlas which was the culminating point in the work of the late M. Loewy, and which represents one of the greatest triumphs of modern astronomical photography. On behalf of the Lunar Section of the British Astronomical Association, Mr. Goodacre will exhibit the superb collection of drawings [illegible] Congregation [illegible].

The [illegible] will be held in the [illegible] building [illegible] president of [illegible] Baron de [illegible] Committee [illegible] invite the co-operation of [illegible] in order to make [illegible] success, and [illegible] the Secretary [illegible] pleased to receive [illegible] from [illegible] who may be able to contribute exhibits, no matter how modest, bearing on the subject. All communications should be addressed to Señor D. Salvador Raurich, Calle Gran Via Diagonal, 467, Barcelona, Spain.

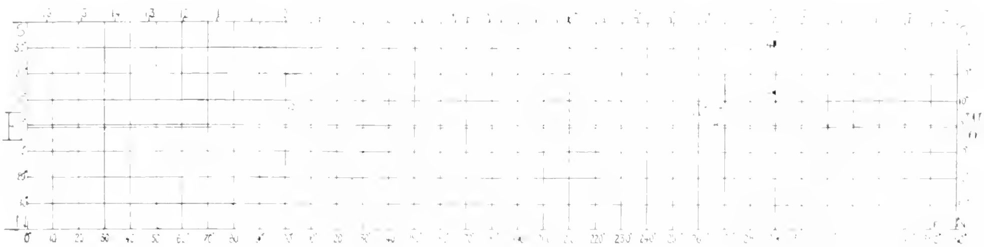
WM. PORTHOUSE.

SOLAR DISTURBANCES DURING DECEMBER, 1911.

By FRANK C. DENNETT.

A FURTHER falling off in solar activity has to be recorded during December. Continuous observation has been hindered both by the low altitude of the Sun and the poor atmospheric conditions. On thirteen days (4, 5, 6, 7, 8, 9, 11, 12, 16, 17, 25, 27 and 30) the disc appeared free from disturbance, and faculae only seen on three (3, 14, and 19). At noon on December 1st the Central Meridian was 205° 2′.

DAY OF DECEMBER, 1911.



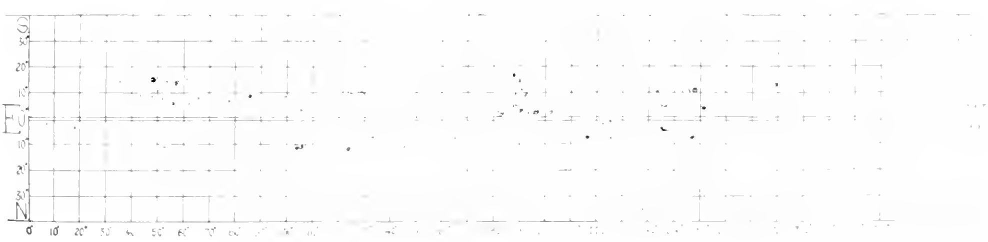
No. 41.—Apparently the only spot disturbance during the month. On the 20th there was a small spot found in the southern spot-zone, the leader of a trail of pores only 22,000 miles in length. When next seen, on the 23rd and 24th, it was as a solitary penumbraless spotlet with a ragged border, and which was quite gone by the following day.

The only other disturbances seen were faculae. On the 3rd such a disturbance was seen within the south-western limb, which must have been situated a little south-east of that shown on the monthly diagram on longitude 260°. On the 14th a small knot near the western limb, in longitude 102° marked the place where No. 39 had disappeared. On the 19th an extensive district streaked with faculae, around the site of No. 40, was visible within the eastern limb, reaching from longitude [illegible] to [illegible]. Again on the 24th there was a bright patch south of No. 41, in latitude estimated as between 30° and 40°.

The only observers able to make effective telescopic observations were Messrs. McHarg, Buss, and Dennett.

Our second diagram shows the positions of the whole forty-seven spot disturbances seen during the year 1911, six of which were rather secondary or attendant outbreaks. Thirty-two were in southern latitudes, and fifteen in northern. The distribution of the disturbances is a striking feature. In the southern zone, between 35° and 130° there are fifteen outbreaks. Between 166° and 203° twelve more, with five between 241° and 263°, whilst situated by itself is No. 41, between 287° and 290°. Thus it will be seen that from 130° to 166°, 203° to 241°, 263° to 287°, and 290° to 35° the surface has apparently been quite free from spots. In the northern zone three small disturbances have occurred between 6° and 58°, seven between 103° and 170°, and five between 213° and 258°. The regions between 58° and 103°, 170° and 213°, also 258° and 6° in the northern hemisphere, have also thus been free from outbreaks as well.

DISTRIBUTION OF SPOT DISTURBANCES, 1911.



THE FACE OF THE SKY FOR MARCH

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

[illegible]

TABLE 6.

	Mars					Jupiter					Saturn	
	P	B	L	Q	q	P	B	L_1	L_2	T_1	P	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 7.

m, *e* denote morning and evening respectively. Greenwich Civil Time is used throughout, the day commencing at midnight.

P is the position angle of the body's North Pole, measured eastward from the North point of the disc. B, L are the Heliographical or Planetographical latitude and longitude of the centre of the disc. In the case of Jupiter there are two systems of longitude, one for the Equator the other for the Temperate Zones.

T denotes the time of passage of the zero meridian across the centre of the disc. Intermediate passages for Jupiter may be found by applying multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ for the two systems; for Mars apply multiples of $24^h\ 39^m$.

Q, q for Mars are the position angle and amount of the greatest defect of illumination.

THE SUN crosses the Equator and Spring commences at 12^h *e* on March 20th. Its semi-diameter diminishes during the month from 16′ 10″ to 16′ 2″. At Greenwich it rises at $6^h\ 48^m$, sets at $5^h\ 37^m$ on March 1st; rises at $5^h\ 40^m$, sets at $6^h\ 29^m$ on March 31st.

Date.	Star's Name.	Magnitudes.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Mean Time.	Angle from N. to E.
1912			h m		h m	
Mar. 3	l Leonis ..	5·3	4. 2 *m*	88	4.50 *m*	334
,, 4	13 Virginis	5·0	7.40 *e*	140	8.37 *e*	272
,, 4	η Virginis	4·0	8. 7 *e*	93	9. 0 *e*	331
,, 6	B.A.C. 4445	7·1			2.24 *m*	318
,, 9	B.A.C. 5220 ...	6·7			2. 0 *m*	311
,, 9	B.A.C. 5253	5·4	4.21 *m*	123	5.41 *m*	282
,, 9	B.A.C. 5286	5·4	7.17 *m*	105	8.32 *m*	282
,, 10	B.A.C. 5505	6·0	—		2.48 *m*	16
,, 22	δ Arietis	4·6	0.24 *e*	110	10. 5	216
,, 23	36 Tauri	5·6	7.54 *e*	23	8.26	316
,, 23	BD + 23° 624	7·0	9.30 *e*	12	—	
,, 27	BD + 24° 1063	7·0	0.20 *e*	170		
,, 27	λ Cancri	5·9	10.11 *e*	181	10.35 *e*	223

From New to Full the Disappearances take place at the Dark Limb, from Full to New the Reappearances do so.

TABLE 8. Occultations of stars by the Moon visible at Greenwich.

THE MOON is Full March [illegible] *m*; Last Q., 11^d [illegible]; New, 18^d 10^h 9^m *e*; First Q., 26^d [illegible] *m*. Apogee [illegible] *m* (semi-diameter [illegible]); Perigee [illegible] *e* (semi-diameter 16′ 15″). Maximum Librations: Feb. 29, 7° S.; March [illegible] W.; March 13, 7° N.; March 21, 5° E.; March 27, 7° S.; April 3, 5° W. The letter indicates the direction on the limb of the region brought into view. E. W. are towards Mare Humorum and Mare Crisium respectively.

MERCURY is too near the Sun to be seen at the beginning of the month, but is well placed as an evening star at the end of it. Its semi-diameter increases from 2½″ to 4″. The fraction of disc illuminated diminishes from 1·0 to 0·5.

VENUS is a morning star, badly placed for Northern observers. Its semi-diameter diminishes from 6¼″ to 5½″, fraction of disc illuminated increases from [illegible] to [illegible].

MARS is an [illegible] star, but [illegible]; the semi-diameter diminishes from 5[illegible] to [illegible]. It [illegible] on March 19th.

JUPITER is [illegible] morning star. [illegible] increases from 17[illegible] to 18[illegible], the [illegible] defect of illumination [illegible]. The [illegible] as seen with an inverting telescope [illegible]

Day.	West.	East.	Day.	West.	East.
Mar. 1	321	4	Mar. 17	[illegible]	4
.. 2	32	14	.. 18	[illegible]	[illegible]
.. 3	3	24 1●	.. 19	[illegible]	[illegible]
.. 4	1	234	.. 20	[illegible]	4
.. 5	2	134	.. 21	[illegible]	124
.. 6	1	[illegible] 2●	.. 22	☉	4
.. 7	34	12	.. 23	[illegible]	[illegible]
.. 8	34	[illegible]	.. 24	[illegible]	2
.. 9	432	1	.. 25	[illegible]	[illegible]
.. 10	4	2 3● 1●	.. 26	[illegible]	1●
.. 11	41	23	.. 27	[illegible]	3
.. 12	42	13	.. 28	[illegible]	3 2
.. 13	41	3 2●	.. 29	[illegible]	2
.. 14	43	12	.. 30	432	
.. 15	31[illegible]		.. 31	[illegible]	2
.. 16	32	14			

Phenomena visible at Greenwich [illegible] I. Sh. I. 5h 15m I. Tr. I., 6h 12m I. Sh. E.; [illegible] III. Oc. D. 4h 47m I. Oc. R. 6h 13m III. Oc. R.; [illegible] II. Sh. I. 6d 4h 18m II. Oc. R.; 9d 5h 53m I. Sh. I. [illegible] I. Ec. D. 3h 16m 57s III. Ec. D. 4h 58m [illegible] III. Ec. R.; 11d 2h 34m I. Sh. E., 3h 40m I. Tr. E.; [illegible] II. Ec. D.; 15d 1h 58m II. Tr. E.; 17d 5h [illegible] I. Ec. D.; 18d 2h 14m I. Sh. I. 3h 20m I. Tr. I. 4h [illegible] I. Sh. E., 5h 42m I. Tr. E.; 19d 3h 1m I. Oc. R.; [illegible] II. Ec. D.; 21d 1h 52m III. Tr. I., 3h 47m III. Tr. E.; [illegible] II. Tr. I., 2h 1m II. Sh. E., 4h 29m II. Tr. E.; 25d [illegible] I. Sh. I., 5h 19m I. Tr. I.; 26d 1h 29m 37s I. Ec. D., [illegible] I. Oc. R.; [illegible] 0h 48m I. Sh. E., 2h 0m I. Tr. E.; 28d [illegible] III. Sh. I., 2h 50m III. Sh. E., 5h 38m III. Tr. I.; 29d 1h 5[illegible] II. Sh. I., 4h 20m II. Tr. I., 4h 36m II. Sh. E.; 31d [illegible] II. Oc. R. All these phenomena are in the morning hours. Attention is drawn to the almost simultaneous eclipses of I. and III. on the 10th. The eclipses occur high left of the disc in the inverted image, taking the direction of the belts as horizontal.

SATURN is an evening star, drawing near the Sun. Equatorial semi-diameter 8½″; major axis of ring 39[illegible]″, minor 14[illegible]″. The times of some Eastern elongations of the Satellites are given, intermediate ones are found by applying multiples of 1d 21h for Tethys, 2d 18h for Dione. Tethys 5d 4h *m.* [illegible] *noon*, [illegible] *m.*; Dione [illegible] to [illegible] *m.* [illegible] Titan and Iapetus [illegible] for Inferior and Superior Conjunctions [illegible] *m.* W. [illegible] *m.* [illegible] Iapetus [illegible]

URANUS is a morning star, but very badly placed. [illegible] diameter [illegible].

NEPTUNE [illegible] December [illegible]

COMETS. [illegible] Comet [illegible] 1911, discovered [illegible] M. Schaumasse [illegible] November 30th.

[illegible] 1912, Feb. [illegible] G.M.T.

[illegible]

Ephemeris for [illegible]

	R.A.	S. Decl.		R.A.	S. Decl.
Feb. 2	17 57 [illegible]	[illegible]	March 5	19 4[illegible]	11 [illegible]
.. 6	17 54 2[illegible]	[illegible]	.. 9	1[illegible] 53 42	[illegible]
.. [illegible]	18 [illegible]	[illegible]	.. 13	[illegible] 0 2[illegible]	[illegible]
.. 14	18 20 [illegible]	[illegible]	.. 17	[illegible]	[illegible]
.. 18	18 42 [illegible]	[illegible]	.. 21	[illegible]	[illegible]
.. 22	18 57 [illegible]	[illegible]	.. 25	[illegible] 4[illegible]	11 [illegible]
.. 2[illegible]	19 12 [illegible]	[illegible]	.. 29	[illegible] 51 53	11 35
March 1	19 26 [illegible]	[illegible]			

The comet is brightest at the end of January, but is then of only the 10th magnitude. It is a morning star.

METEORS. The following list of showers is due to Mr. W. F. Denning.

Date.	Radiant. R.A.	Radiant. D.	Remarks.
Mar. 1–4	166	[illegible]	Slow, bright
.. 14	25[illegible]	54	Swift.
.. 18	310	76	Slow, bright
.. 24	161	58	Swift.
.. 27	220	32	Swift, streak
Mar. to May	203	62	Rather swift.

EVERY THIRD MINIMUM OF ALGOL (Period 2d 20h 49m) March 1d 10h 16m *m.*, 10d 0h 4[illegible]m *m.*, 18d [illegible]h 9m *e.* 27d 5h 30[illegible]m *m.*

DOUBLE STARS. The limits of R.A. are 9h to 11h.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
[illegible] Ursae Majoris	9 [illegible]2	N. 67 [illegible]	5, 8[illegible]	[illegible]	[illegible]	Greenish yellow, [illegible]. The position is [illegible] rapid motion [illegible] periastron.
Lalande 17954	9 [illegible]2	N. 23 [illegible]	[illegible], 7	[illegible]	7	White.
38 Lyncis	9 [illegible]3	N. [illegible] 2	4, 7	236	3	White, blue.
39 Lyncis	9 [illegible]	N. [illegible]	6, 8	32	6	White, blue.
21 Ursae Majoris	9 1[illegible]	N. 5[illegible]	7, 8	313	[illegible]	White, blue.
23 Ursae Majoris	9 2[illegible]	N. [illegible]	4, [illegible]	27[illegible]	2[illegible]	Greenish-white, [illegible]
ω Leonis	9 23	N. [illegible]	6, 7	[illegible]27	1	Yellow.
Groomb. 1500	9 30	N. [illegible]	7, 8	2[illegible]	[illegible]	Yellow.
γ Leonis	1[illegible] 15	N. [illegible]	2, 3	118	4	[illegible]
Struve 1430	10 [illegible]5	N. [illegible]	[illegible], 8	11[illegible]	1[illegible]	White.
49 Leonis	10 [illegible]5	N. [illegible]	6, 9	150	2	White, blue.
35 Sextantis	10 [illegible]0	N. 5 [illegible]	6, 7	24	6	Yellow, blue.
Lalande 20700	1[illegible] 43	S. [illegible]8	6, 7	17	[illegible]	[illegible]
			7, 8	[illegible]	[illegible]	
54 Leonis	10 51	N. 25 [illegible]2	5, 7	1[illegible]7	6	[illegible]

[illegible] and Nebulae.

N.G.C.	R.A.	Dec.	Remarks.
[illegible]		S. [illegible]	[illegible] (contains [illegible])
[illegible]		N. [illegible]	Oblong [illegible]
		N. [illegible]	[illegible]
[illegible]		[illegible]	Br[illegible]
[illegible]		N. [illegible]	Two [illegible] nebulae [illegible]
[illegible]		S. [illegible] 5	Faint [illegible]
[illegible]	[illegible]	N. [illegible]	Two faint nebulae.
[illegible]		S. 18 2	Bright planetary nebula.
[illegible]	[illegible] 23	N. 20 [illegible]	Bright oblong nebula: 11 mag. nucleus.
[illegible]	[illegible] 44	N. 13 [illegible]	Two faint nebulae, some others near.

The Second [illegible] Eclipse of April 17. It will probably be [illegible] for those who propose to go to the central line in this eclipse to have accurate information sufficiently long beforehand to make their arrangements.

The following positions are based on a combination of the American Ephemeris with the Nautical Almanac, going ⅔ of the way from the former to the latter. (The reasons for this course are given in the Journal of the B.A.A. for December.) T, A denote the probable durations of totality or annularity. It should be noted that the phrase "annularity" is really not suitable for France, as the appearance will probably be that of a few beads of sunlight at the Moon's edge, not of a continuous ring.

Longitude.	Latitude.	Duration.
[illegible] 38·7 W.	39 55·6 N.	[illegible] T
8 2·7	41 24·[illegible]	1·4 T
[illegible] 21·[illegible]	42 52·8	1·4 T
[illegible] 32·5	44 21·[illegible]	·5 T
2 [illegible]	45 49·[illegible]	·5 A
[illegible]·7 W.	47 17·5	1·3 A
1 48·3 E.	48 45·2	2·[illegible] A
[illegible] 29·2	5[illegible] 12·4	4·[illegible] A
7 8·[illegible]	51 39	5·[illegible] A
10 17·[illegible]	53 4·[illegible]	7·[illegible] A
13 51·5 E.	54 28·5 N.	[illegible] A

The track enters Portugal at Ovar, which was also on the central line in 1900, when it was occupied by the Astronomer Royal, and many other English Astronomers. It passes eighteen miles due east of Oporto, enters Spain near the village of Verin, in Orense, passes seven miles due east of Villafranca, in Leon, two miles east of Oviedo, and leaves the peninsula some seven miles east of Gijon. According to the above figures it will cease to be total while traversing the Bay of Biscay. It enters France six miles S.E. of Les Sables d'Olonne, in Vendée, passing fourteen miles south of Angers, nineteen south of Le Mans (noted for aeroplane experiments), through St. Germain en Laye, in the western environs of Paris, very near Namur in Belgium, and onward into Germany and Russia. Details for the partial eclipse in the British Isles will be given next month.

CORRESPONDENCE.

SWEEPINGS.

To the Editors of "KNOWLEDGE."

Sirs,—Mr. Enock evidently has misread Westwood's "Introduction to the Modern Classification of Insects," or he could not have written of *Elenchus tenuicornis* Templeton, of which but one example had hitherto been recorded over fifty years ago. In the text Westwood gives no author's name, but in the synopsis bound up at the end of the volume he gives it correctly *Elenchus tenuicornis* K. Moreover, in the few pages in which he deals with *Elenchus* and the other genera in the order *Strepsiptera*, he refers to specimens of this insect having been taken by Stephens, Dale, Haliday and Walker, in addition to that by Mr. Templeton (which he queries as belonging to another species *Walkeri* Curtis), and although he does not expressly mention the insect, he was obviously aware of the mutilated specimen on which Kirby based his description in 1811. There are thus no less than [illegible] separate and distinct captures of this species referred to in the volume consulted by Mr. Enock.

There has been considerable hesitation in admitting the claims of *E. Walkeri* Curtis to rank as a distinctive species. Mr. S. [illegible] Saunders, in his monograph of the *Stylopidae* (*Trans. Ent. Soc.*, 1872), queried it, but very properly divided the records between the two species described, and the framers of [illegible] lists, with one accord, have refused to admit more than one distinct species, *E. tenuicornis* K. In the latest monograph of the *Strepsiptera*, written by W. D. Pierce and published [illegible] year in the "*Genera Insectorum*," the author elevates *E. Walkeri* Curtis to specific rank. He [illegible] adds the important fact that "*E. tenuicornis* K. [illegible] to be parasitic on leaf hoppers, probably of the genus *Liburnia*."

Mr. Enock is to be congratulated on his success after so many years' search, and it may be that with this hint he will be successful in elucidating still more of the life history of these wonderful, minute parasites.

BARNSLEY. E. G. B.

THE VELOCITY OF LIGHT.

To the Editors of "KNOWLEDGE."

Sirs,—In the October number of "KNOWLEDGE," you kindly published a letter from me suggesting that the Velocity of Light, should be re-calculated from observations to be made at different heights above the earth's surface, so as to see what retardation, if any, is caused in the velocity of light by the earth's atmosphere. My suggestion was founded on the fact that we can see a flash of lightning, which apparently usually passes from the thunder cloud to the earth; and because the human eye is not capable of seeing anything that passes across its vision in less than about one-tenth of a second, it seems to me that a flash of lightning takes more than one tenth of a second to pass from cloud to earth.

As a thunder-cloud is seldom at a greater height than two miles above the earth, does not the flash of lightning take at least one-tenth of a second to travel this distance?

Mr. Charles E. Benham in the December number of "KNOWLEDGE," page 471, suggests that I was trying to hoax your readers. Nothing was further from my thoughts, and I will try to explain myself more thoroughly.

The filament of an electric light causes obstruction to the current of electricity flowing from the generating station, and the obstruction is so great that heat is generated and the

In [illegible] Sweepings" in "KNOWLEDGE," Volume [illegible], page 400, Figure [illegible] was by an accident labelled "female" instead of [illegible] after Mr. Enock had passed his proofs.—Eds.

filament becomes red or white-hot. If the wire conducting the current were continuous, there would not be friction sufficient to cause heat or light, so that in passing through the filament the velocity of current must be retarded.

An electric lamp can be seen for miles in a clear atmosphere, but it cannot pierce a London fog for any great distance. Is not the velocity of the electric current reduced in this and similar cases, owing to the obstruction of the filament, or of matter in the earth's atmosphere?

And so, in the case of a flash of lightning from cloud to earth; the air being a bad conductor of electricity may retard its velocity more or less according to the dryness and quantity of floating matter in the air. If the atmosphere offered no obstruction to the friction or impulses which cause light, there would be no light; otherwise, would not the ether in the depths of space always be illuminated by the light of the millions of suns in the heavens to such an extent, by its accumulation, as to turn our night into day?

Of course, if I am mistaken in supposing that there is an appreciable lapse of time between the commencement of a flash in a thunder-cloud and the end of the same flash at or near the surface of the earth, no retardation in the velocity of light may be caused in the way I have suggested.

As an enquirer I must beg your kind indulgence for thus troubling you with the expression of my thought.

G. R. GIBBS, Colonel (Retired).

CANMORE,
WESTBOURNE PARK ROAD,
BOURNEMOUTH.

THE TRISECTION OF AN ANGLE.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Bingley's method of dividing angles into three equal parts, published in the November number of "KNOWLEDGE," is, so far as I am aware, original, and gives accurate results for small angles. In attempting to find an approximately correct solution of the problem for larger angles, I have hit upon two simple constructions, to which I now venture to call attention. The first is an alternative method of trisecting small angles, which is not only simpler, but also more nearly exact, than that of Mr. Bingley; the second is a method applicable to larger angles.

METHOD I.—Let B A C be the angle to be divided. From A describe arc B C. Bisect arc B C in D, and join D A. Bisect A B in E, and A C in F. Join E D and F D. Bisect E D in G, and F D in H. Join A G and A H, and produce them to meet arc B C in J and K respectively. Then the angle B A C is divided into the three equal angles, B A J, J A K, K A C.

METHOD II.—As before, let B A C be the angle to be divided. From A describe arc B C. Bisect arc B C in D, and join D A. Bisect A B in E, and A C in F. Join E D and F D. Bisect E D in G, and F D in H. Join B D and D C. Join A G and A H, and produce them to meet chords B D and D C in N and P respectively. Bisect A D in L, and A L in M. Join M N and M P, and produce them to meet arc B C in J and K respectively. Join J A and K A. Then the angle B A C is divided into the three equal angles, B A J, J A K, K A C.

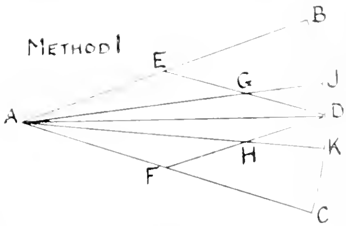


FIGURE 63.

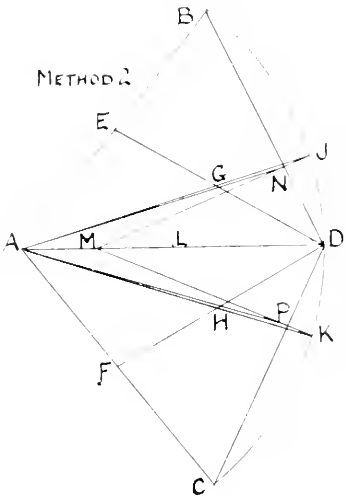


FIGURE 64.

Angle BAC (2α)	Error in Angle JAK (2β)		
	Bingley	Method 1	Method 2
	excess	deficit	deficit
15°	23"	11"	-
30°	3' 4"	1' 32"	-
45°	10' 25"	5' 13"	2"
90°	1° 26' 41"	43' 21"	1' 0"
135°	5° 13' 25"	2° 36' 45"	8' 11"
180°	13° 44' 24"	6° 52' 12"	39' 0"

FIGURE 65.

It is obvious that the smaller the angle B A C, the more nearly do A J and A K coincide with A N and A P respectively, and thus approximate to the solution by Method I.

In order to ascertain the degree of accuracy of the three methods—that of Mr. Bingley and the two described above—I have examined each of them analytically. If 2α be the angle B A C, and 2β be the middle (J A K) of the three component angles, then

By the Bingley method

$\cot\alpha$ [illegible] $\frac{1}{2}\operatorname{cosec}$ [illegible] $\cot$ [illegible]

By Method I

$\cot\alpha$ [illegible] $2\operatorname{cosec}\beta$ [illegible] $\cot\beta$.

By Method II

$\cot\alpha$ [illegible] cosec [illegible] $\cot\beta$ [illegible] $\operatorname{cosec}\beta$

If each of these equations be solved for different values of α, the error inherent in each method can be determined. Some of these are given in the table. It is seen that the error due to using Method I is exactly half that present in Mr. Bingley's method, and that neither of them can be used with reasonable accuracy for angles much above 45°. On the other hand, Method II is sufficiently exact for angles up to 135°, and even at 180° the error is only thirty-nine minutes. In Mr. Bingley's method the middle angle is too large, and in the other methods it is too small.

D. HALTON THOMSON.

KENELLLIB, BROADLANDS ROAD,
HIGHGATE, N.

THE TRISECTION OF AN ANGLE.

To the Editors of "KNOWLEDGE."

SIRS,—In the issue of "KNOWLEDGE" for November, 1911, I noticed a problem on the trisection of an angle by a geometrical method.

As the geometrical trisection of an angle has long been supposed to be impossible, I thought at first (for I am naturally credulous) that a great discovery had been made; but when I tested the matter by a numerical example, the construction, as given by Mr. Bingley, proved to be incorrect from a mathematical point of view, although it gives a rough approximation to the truth. Suppose the angle to be divided is 22° 30'.

According to the Bingley construction, we obtain the following values for the three divisions of the angle:

7°	31'	18"
7	27	24
7	31	18

The middle angle shows a deviation from the others of nearly four minutes, and the deviation would be greater for a larger angle. I leave to the geometrical experts the task of pointing out the fallacy in the construction; for such there must be if the construction is supposed to be exact, not merely an approximation.

[illegible]

BOSTON, MASS.

[illegible] TEMPERATURE.

To the Editors of "[illegible]"

SIRS,—W[illegible] Mau [illegible] I have [illegible] thermometer [illegible] and I [illegible] I took [illegible] temperature [illegible]

The [illegible] and [illegible] the [illegible] temperature [illegible] the daytime was [illegible] below freezing.

The thermometer was not shaded in any way, but exposed to the full force of the sun from [illegible] On eleven nights out of the [illegible] that I spent on the Mau, there [illegible] frost, the water in the wash-[illegible] being covered with ice about a quarter of an inch thick. The ground temperature [illegible] from 30° to 150° F during the [illegible] 6 a.m. to 6 p.m. Of course, the Mau Escarpment is one of the coldest inhabited parts of British East Africa, and [illegible] the settled districts in the Highlands, higher temperatures are obtained, but nothing to what one would expect, situated on the Equator as we are.

BRITISH EAST AFRICA. D. G. CROFTS.

FIGURE 66.

Diagram showing Range of Temperature in open on Mau Escarpment in October 1911. Latitude about 0° 45' S. Height about 9500' above sea level.

A DURHAM BARROW.

To the Editors of "KNOWLEDGE."

SIRS,—I enclose a photograph (see Figure 67) of a Prehistoric Skeleton and Flint Knife, found in a secondary deposit in the S.E. edge of a round barrow on Batter Law, near Hawthorn, Co. Durham, on June 10th last. Batter Law is a hill forming part of an elevated tract of glacial debris known as Hesledon Moor, and rests on the Magnesian Limestone. The barrow occupies the highest point of the hill and has a diameter of about thirty-five feet, and height of about four-and-a-half feet, but has been much disturbed by ploughing and other operations and consequently obscured; it is made of stones and earth. It is not mentioned by Canon Greenwell in "British Barrows."

Permission to explore was kindly granted by the proprietor of the ground, Mr. J. S. G. Pemberton, J.P., of Hawthorn Towers; and I started by opening up the S.E. side of the mound anticipating the possible occurrence of a secondary deposit on the S. or E. side. Almost immediately we encountered a large mass of sandstone set up on edge and adjoining this a large oblong whinstone boulder; on clearing away the earth from the south[illegible] was encountered which proved to be a slab of sandstone fallen down and covering the feet of the skeleton, the bones of which were [illegible] and crushed and scattered beneath it. The large whinstone [illegible] proved to be lying across the [illegible] where it had probably been thrown when the rough cist was disturbed by ploughing. The skeleton proved to be that of a large and powerful apparently middle-aged man, laid on its right side, facing South, head to the West, the back of the head nearly touching the western slab of the cist, the knees drawn up and the right arm bent round and resting on the left side of the body.

The bones of that side of the body in contact with the ground had been largely removed by solution, but those of the left side were better preserved. The skull was somewhat crushed and the facial bones mostly destroyed, but the dentition was intact and well preserved, except the two upper front incisors which seem to have been lost during lifetime. The skull is now undergoing reconstruction and examination in Canon Greenwell's hands.

Approximately in front of the knees of the skeleton was found a very beautifully-chipped knife of reddish mottled flint, quite sharp and unweathered. It is very skilfully flaked over the entire upper surface, while the under-side shows the original surface of the flake, which is untouched except for some slight secondary chipping at the base and towards the point for the purpose of removing some slight excrescences.

It is a good example of a class of implement which have been several times recorded from barrows, but not hitherto, to my knowledge, from this county. It measures three-and-five-eighths inches in length, by one-and-one-eighth inches in breadth.

The occurrence of a cist burial as a secondary deposit is unusual; but, perhaps, two upright slabs of sandstone with a large mass of whinstone, whose position is uncertain, can scarcely be truly called a cist; and may have been merely intended to protect and confine the body. The cist lay as nearly as possible east and west.

C. T. TRECHMANN, B.Sc.

FIGURE 67.

A KNOWLEDGE OF NAVAL PICTURES AND PRINTS.

By A. M. BROADLEY.

Author of "Napoleon in Caricature," etc.

THERE is no more popular or interesting form of collecting than that which includes within its sphere

FIGURE 68.

of operations the *rariora* of the Navy, ranging as they do from medals and autograph letters to pictures, engraved prints, portraits and caricatures, valentines, songs and jest books. That an impetus will be given to the collection of naval views of every description by the opportune appearance of Mr. Harry Parker's "Naval Battles" there can be little doubt. Ever since the end of the eighteenth century three generations of the same family have distinguished themselves in the foremost rank of London print-dealers, and now the present head of the firm has brought all his expert knowledge and personal experience to bear on the production of a very delightful volume which is not only an exhaustive descriptive catalogue of the superb series of engravings formed by Commander Sir Leopold Cust, but affords the humblest collector a useful and intelligible *vade mecum*. To endeavour to collect naval prints without the aid of such a guide as Mr. Parker has now provided would be sheer folly. If anything could enhance the good work done by Mr. Parker, it would be the admirable introduction supplied by Commander C. N. Robinson, the author of "The British Fleet," whose books may be found on almost every ship of the British, American and German navies. It is assuredly in the eternal fitness of things that the namesake and godson of one of the best known and most daring of the Admirals of the Crimean War times should, at the commencement of the twentieth century, have made many important contributions alike to the history and the iconography of the Service he loves so well.

FIGURE 69.

Commander Robinson points out that the picking up of naval prints need not of necessity be a monopoly of the millionaire. The intelligent collector will, at the onset, limit his endeavours to one particular channel, and if he does this he will be astonished at the success he achieves in all sorts of out-of-the-way and unexpected places. The writer has seen a large album filled with naval "Valentines," many of which throw a curious light on the inner life of Jack Tar during the great wars of the eighteenth century. The same may be said of "chaunties" (a practically inexhaustible subject, for Jack has always loved music almost as much as tobacco or grog) and caricatures. One cannot help hoping that in the near future Commander Robinson will deal at length with the last-named subject, which has for some years engrossed his attention. A whole chapter might be devoted to the British caricatures of Nelson, many of which are very interesting as sidelights of naval history. Napoleon, for some reason or another, never incited his official caricaturists to lampoon Nelson as they did Pitt. The only French caricature of Nelson the writer has ever met with

FIGURE 70.

represents a corpulent [illegible] with a grotesque head, wearing a [illegible] cocked hat and standing up in a tiny boat which is being rowed by a diminutive sailor. Under his arm is a huge official portfolio, and beside him a letter addressed to Lady Hamilton. Napoleon evidently knew the weak point in his adversary's armour. Sir Charles Cust has himself specialized in the way Commander Robinson indicates. We are told that:

> He has gathered together every engraving which in any way illustrates his own particular subject—British battles by sea. The collector who acts on these lines, and selects a definite object possessing a personal attraction and connection, has one great advantage over the more orthodox connoisseur of prints; for he does not want to worry about "states" or "margins," or other points which require special knowledge, if not a thorough technical education. The intrinsic value of the print for him will rest in its subject, and although he may desire and appreciate technical beauty if he can get it, it will be less an object than human and historical interest. The pleasure of picking up—perhaps as a bargain—yet another example, and adding it to one's gallery or cabinet, can only be adequately realised by the ardent collector.

Sir Charles Cust has succeeded in obtaining no less than seven hundred aquatints, engravings and lithographs relating to British naval achievements at sea. He begins with Julius Cæsar's invasion of Britain in 55 B.C., and ends with the operations at the entrance of the Pei-Ho River on June 25th, 1859. For Sir Charles Cust the piquant satirical print has apparently no charm, nor is any mention made of the numerous glass-pictures which for long years decorated the mariner's cottage and kept green the memory of Nelson, the Dorset Hoods and Sir Thomas Hardy. At least twenty of these quaint illustrations relate to the tragedy of Trafalgar. A few of them possess a certain amount of artistic merit. To those who reside on or near the English littoral this book will prove exceptionally interesting. Many of the keenly-contested engagements which have been fought within sight of our shores are almost forgotten. Most Dorset men, for instance, are aware of the discomfiture of the Spanish Armada off Portland Bill in the eventful summer of 1588, but some seventy years later a scarcely less important action took place in the same waters. The second "Battle of Portland" took place in February, 1653, and lasted three days. The best known of the English admirals engaged were Blake, Monck, Peacock, Martin and Penn, and in the end they gained a signal triumph over Tromp and de Ruyter:

> About twenty English ships were first to engage the enemy, and were nearly annihilated by the overwhelming number of the Dutch, but as soon as the remainder of the fleet arrived the Dutch endeavoured to make their escape, and on the 19th arrived off the Isle of Wight. Blake (who had previously won an abundant crop of laurels on land at Bridgwater, Taunton and Lyme Regis) then re-engaged with great desperation, and after a most valiant fight drove the enemy before him and captured or destroyed eleven ships of war and sixty merchantmen. One thousand five hundred men were killed and seven hundred taken prisoners.

Sir Charles Cust has discovered no less than four illustrations of this comparatively little-known engagement—one of English origin (dated 1803), and three Dutch. M. Küsell published an etching of the battle as early as March 24th, 1653. Curiously enough, the name of that gifted artist, Thomas Rowlandson, does not appear in Mr. Parker's carefully prepared index. This is probably explained by the fact that Rowlandson's naval pictures were not, strictly speaking, descriptive of actual engagements, although the reproductions of the two original drawings in the present writer's collection obviously relate to naval warfare. As far as the writer is aware, engravings from these admirable water-colours do not exist. They may be supplemented very effectively by the spirited and striking sketch by "W. H." which shows the "Victory" as she appeared just fifty years after Nelson's death and the date of Rowlandson's drawings.

THE ROYAL ANTHROPOLOGICAL INSTITUTE.

MR. ALFRED P. MAUDSLAY, F.S.A., F.R.G.S., delivered his Presidential Address at the Annual General Meeting of the Royal Anthropological Institute, on Tuesday, January 23rd. Mr. Maudslay said that even at the present day the idea that the origin of man does not form a fit subject for scientific enquiry has not yet entirely died out, and this feeling has militated against anthropology becoming a popular study. Meanwhile the immediate and energetic prosecution of anthropological studies is of vital necessity, since the material with which this science deals is becoming rarer every year, as primitive customs yield to civilization. The fact that man's physique is less subject to alteration gives a permanent value to the study of physical anthropology.

Mr. Maudslay confined the bulk of his remarks to certain points in the archaeology of America, where there are traces of many extinct civilisations. He incidentally pointed out that many misunderstandings between European and barbarous races might be avoided by a knowledge of elementary anthropology, and mentioned that the Institute had never ceased to press upon the Government the advisability of establishing in this country an anthropological bureau, which would be of material assistance to colonial administration.

The address terminated with an appeal to all fellows of the Institute to do their utmost to make a success of the International Congress of Americanists in London, which will be held during May, 1912, saying that though we possess in England more pre-Columbian objects of interest than are preserved in any other European country, it is the first time that we have acted as hosts to the leaders of American research.

REVIEWS.

BIOLOGY.

Life in the Sea. By JAMES JOHNSTONE, B.Sc., Fisheries Laboratory, University of Liverpool. 150 pages. Numerous illustrations. 6¾-in. × 4½-in.

(Cambridge University Press. Price 1s. net.)

This is a fascinating introduction to a study of the economy of the sea, a department of marine biology which has made great strides within recent years, partly through the quantitative plankton investigations which estimate the productivity of a sea-area and partly through the correlation of the minute life of the sea with currents and other physical conditions. Mr. Johnstone has been actively engaged in marine biological investigations for many years past, and he tells his tale with vigour and clearness. He starts off with an imaginary walk along the sea bottom to North America, which introduces the reader to a variety of zones and faunal areas. His second chapter is devoted to rhythmical changes in the sea,—"the tides, the annual waves of temperature, salinity and sunlight; annual outbursts of animal and vegetable life; animal and plant migrations; spawning periods; fishery seasons and the like." In an admirable analysis of the factors of distribution the subject of Chapter III Mr. Johnstone discusses many interesting facts, such as that the polar and temperate seas are, generally speaking, far richer in life than are tropical seas, and the lengthening out of life at low temperatures. To our thinking the author speaks the words of wisdom when he notes in regard to migrations that it seems to be rather straining after generality to describe all these as tropisms, and that the behaviour of an animal at any time is modified by its past experience which is registered within it. In the fourth and fifth chapters the different modes of nutrition and the sources of food are discussed, and attention is paid to the recent theory or heresy that many marine animals feed "saprozoically" by the absorption of dissolved organic matter in the sea, on the stock of the sea-soup as it were. The amount of carbon compounds (other than carbonates) and of nitrogen compounds (other than ammonia or nitrates) dissolved in sea water is small, but it is greater than the amount of proteid or carbohydrate contained in similar volumes of water in the form of plankton. We cannot do more than indicate the general trend of this delightful and stimulating volume, which we would recommend with the greatest cordiality. It should not be missed by any one interested in the science of the sea.

J. ARTHUR THOMSON.

CHEMISTRY.

Some Chemical Problems of To-day. By R. K. DUNCAN. 54 pages. 34 illustrations. 8½-in. × 5½-in.

(Harper & Bros. Price 2 dollars net.)

Professor Duncan is an enthusiast in the matter of technical chemistry, and his book is a veritable mine of suggestion upon the practical applications of the science. In every industry there are chemical problems in pressing need of solution, and here we have an outline of many of these difficulties, which will tax all the resources of the trained chemist to meet.

And is not, so the author urges, an education which tends to the solution of such industrial problems as good an intellectual training as that usually given? His attitude upon this question may be summarised in his own words: "The many and important actual opportunities that lie everywhere at hand for applying scientific knowledge and the scientific method to the manufacturing needs of men make one frankly consider why trained and earnest men should devote laborious days to making diketotetrahydroquinazoline, or some equally academic substance, while on every side these men are needed for the accomplishment of real achievement in a world of manufacturing waste and ignorance."

But, although America has greater facilities for meeting this need than we possess in this country, yet we find Professor Duncan lamenting that "the present state of American manufactures is one of inefficiency." The picture he draws of the position of the research chemist in American works is not a pleasant one to contemplate. He has no security of tenure, and in most cases works under unsuitable conditions, and while his retaining his poorly-paid position depends upon speedy returns for his work in cash, he is rarely given any pecuniary interest in his discoveries, which become the property of his employers. This is the impression left by this part of the book, and the outlook for the future does not appear very hopeful.

But it is not only in the direction of applied chemistry that the reader will find much to interest him in this brightly written and stimulating book, for there are also excellent chapters on "The Question of the Atom," "The Chemical Interpretation of Life," and "The Beginning of Things," in which is given a clear outline of Chamberlin's planetesimal hypothesis, illustrated by a series of beautiful photographs of spiral nebulae, which were taken at the Lick Observatory. The book is so well worth reading in every part that we can forgive the use of words and expressions that grate upon English ears. But why should the author go out of his way to talk about the "young chemist seeking an *arbeit*" or "The trained *chemiker*," when we have English words to convey the same ideas?

C. A. M.

Chemical Phenomena in Life. By FREDERICK CZAPEK, M.D., Ph.D. (Harper's Library of Living Thought). 152 pages. 7-in. × 4½-in.

(Harper and Bros. Price 2/6 net, cloth; 3/6 net, leather.)

In this welcome addition to a well-known series of short monographs Professor Czapek gives a concise, yet readable, account of the present state of our knowledge of the chemical processes involved in what is commonly understood by "life."

The book deals more especially with the biological chemistry of plants, and only incidentally with the allied phenomena of animal life. After a short historical survey of the connection between biology and chemistry, chapters are devoted to protoplasm, colloidal chemistry, the chemical action of living matter, enzymes, and chemical adaptation and inheritance.

Owing to the necessity for severe compression within a small space the subject lacks sufficient elaboration in places, while, on the other hand, it occasionally goes into more detail than is suitable for a book intended for the general reader rather than the specialist.

The author does not attempt to evolve a chemical definition of life, although he lays stress upon many facts tending towards such a definition. Thus, on page 19 he writes, "The final result of our discussion is that there are many reasons for maintaining that protoplasm really is of a peculiar chemical constitution, and that it does not merely represent a mechanical structure."

In this connection it may be mentioned that in several places an attempt is made to draw too sharp a distinction between living and inorganic matter, as, for example, on page 10, where it is stated that the chemist studying inorganic matter "will be accustomed to see that no change takes place in the matter under investigation unless an experiment be made."

This ignores the continual changes which recent researches have proved to be taking place in radio-active (and not improbably) other bodies, with the degradation of one form of inorganic matter into another; changes which in the more rapid cases we can follow, but cannot influence by any experimental means at our disposal.

A. M.

A Handbook of Organic Analysis. By H. Thewlis Clarke, B.Sc., Lond., A.I.C. 264 pages. 23 illustrations. 7½ in. × 5 in.

(Edwin Arnold. Price 5/- net.)

This small book should meet the long-felt want of a concise text-book upon organic qualitative analysis. It deals systematically with the identification of different organic radicles, and organic compounds, and gives a new and most useful classified table of the physical properties of the more common substances. This table will obviate the necessity of frequent references to chemical dictionaries or larger text-books; in future editions it might with advantage be amplified so as to include some of the important compounds omitted. The section of these tables dealing with the identification of different classes of dyestuffs will prove particularly valuable.

The latter half of the book, which deals with the quantitative analysis and determination of the physical properties of organic compounds, does not present the same novel features as the first part, though it describes clearly, and at sufficient length, the different methods of estimation. Even processes not ordinarily found in elementary handbooks, such as, for example, Wijs' method of determining the halogen absorption of unsaturated bodies, are here fully described.

The book is well printed, and illustrated with diagrams where necessary, and we can thoroughly recommend it as a laboratory companion both to the student and advanced worker in organic chemistry.

C. A. M.

CRYSTALLOGRAPHY.

Crystallography and Practical Crystal Measurement. By A. E. H. Tutton, D.Sc., M.A. (Oxon), F.R.S., A.R.C. Sc., Vice-President of the Mineralogical Society. 946 pages. 720 figures in the text and 3 plates. 9-in. × 6-in.

(Macmillan & Co. Price 30/- net.)

The subject of crystallography being one which claims so few ardent students in this country, it is perhaps not to be wondered at that English authors and publishers have for some years refrained from any large and exhaustive publication on the subject. The fine work which has now been published will be heartily welcomed by all crystallographers and will undoubtedly rank as a standard work on the subject.

As its title implies, the book is intended as a guide to the practical measurement of crystals rather than as a complete text-book of crystallography. The author has made every effort to remove all grounds for the assertion, so frequently made, that crystallography can only be studied by mathematicians. Accordingly, while pointing out the real need of a knowledge of higher mathematics for the thorough mastering of crystallography, the author has reduced the computation of the physical constants of crystals to the application of some four pages of simple formulae, all geometrical or analytical proofs of these formulae being omitted.

The first part of the book is devoted to the morphological characters of crystals. A few pages on the nature of crystals serve as an introduction to accurate instructions for the growing and selection of crystals suitable for measurement. The simplest types of goniometers are then described in great detail, and in the fourth chapter the knowledge already obtained is shown to be sufficient to enable the reader to measure completely a crystal of potassium sulphate. After devoting three chapters to the conceptions of crystal axes, face indices and zones, and to the stereographic projection, and the few simple formulae mentioned above, the results of the measurements made in Chapter IV are worked out. The simplification of the mathematics has, perhaps, been carried a little too far and strikes one as being somewhat inconsistent. Thus, while elaborate pains are taken to explain the application of Napier's rules, the reader is left in entire ignorance of the signification of the "zone indices," which are obtained by cross-multiplying the indices of any two faces in the zone. The reader who has little knowledge of mathematics may at first fail to appreciate Chapter IX, which is a truly brilliant *résumé* of the mathematical work on crystal-structure, and will no doubt appeal more to advanced students.

The seven crystal-systems are next studied, commencing with the cubic system, as being the one requiring the simplest calculations, and leading gradually up to the more difficult systems. Two chapters are devoted to each system, one dealing with the elements of symmetry and possible forms in the various classes, the other giving examples of crystals measured by the author, each one completely worked out, the results being tabulated in the form adopted in publications of crystallographic data.

The methods employed for drawing crystals are clearly set forth in Chapter XXV, again with the aid of as little mathematics as possible, but calling attention to Penfield's excellent methods based on the stereographic projection. Twinning and planes of cleavage and gliding are dismissed in two short chapters, and the first part of the book concludes with a description of recent advances in goniometry, the determination of density, and a clear account of the theories of crystal-structure put forward by Fedorov and by Pope and Barlow, this last chapter being a most valuable contribution.

The second part deals mainly with the optical properties of crystals and no pains have been spared to make this part thorough. The chapter reviewing recent ideas on the nature of light and the three succeeding chapters pave the way for the study of the transmission of light through uniaxial and biaxial crystals. The determinations of optical constants are described in the same detailed manner as the measurements in the first part. Two chapters on the crystallographic microscope are full of useful suggestions and descriptions of the most recent methods. The remaining three chapters are occupied with thermal expansion, elasticity and hardness, with a brief summary of the recent work on liquid crystals.

Throughout the book the treatment is better suited to chemical crystallography than to mineralogy. A sufficient supply of material of the highest degree of purity and of perfect crystal development is postulated, and the mineralogist may frequently find himself unable to attain the degree of accuracy which the author has shown to be possible with crystals grown under suitable conditions. This book, however, sets before all crystallographers an ideal at which to aim, and it is to be hoped that its influence in this direction will be widely felt.

The fact which adds enormously to the value of the book is that every branch of the subject which is treated at length is one to our knowledge of which the author himself has contributed very largely. Consequently, we have in this book the results of years of experience in carrying out most accurate and laborious measurements. The care and accurate detail with which the book has been written yield most eloquent testimony to the untiring patience and accuracy which characterise all Dr. Tutton's work.

The figures with which the book is lavishly illustrated are most beautifully reproduced, and the publishers, as well as the author, are to be heartily congratulated and thanked for so valuable a publication.

W. C. S.

MEDICINE.

The Art of Life—The Way to Health and Longevity. By J. L. Chundra, L.M.S. 240 pages. Illustrated. 7½-in. × 5-in.

(Calcutta University. Price 3/- net.)

This interesting little book is unique in many ways. The author is clearly a man of very wide reading, and gives us the combined wisdom of the East and West. Thus we find quotations from the Hindu Scriptures and from the latest American medical journals on the same page, and while ordinary medical prescriptions are given, we are also told that "Persons who have been given up to die are often restored to perfect health in a few minutes by the hands of the Magnetic Healer." The author has written his book for the laity and medical profession alike, but the inclusion among its "varied and valued ingredients" of detailed medical prescriptions and full descriptions of indolaceturia, cretinuria, and so on, would seem to our Western minds a little undesirable if the laity are really expected to read it. Moreover, the English is in places a little obscure. Among some excellent rules for the care of infants we read: "Don't forget to put the child in the sun or sunshade for two hours at least a day."

Nevertheless, the book contains much sound, practical, useful advice, particularly applicable to those resident in warm countries, and every page shows us that the author, if a little over-credulous, has considered most carefully the problems of existence, and knows how to express his meaning clearly, tersely and in a very interesting style.

Further Researches into Induced Cell-reproduction and Cancer. By H. C. ROSS. The McFadden Researches. 63 pages. 5 plates. 9-in. × 5¾-in.

(John Murray. Price 3/6 net.)

The present volume contains a series of papers by Messrs. H. C. and E. H. Ross and J. W. Cropper, on certain changes which they have observed in red and white blood corpuscles, when these are supported on a film of jelly and various chemical substances are made to act upon them. The researches here described are a continuation of those recorded in a volume published a year previously, a review of which appeared in "KNOWLEDGE" for March, 1911, and many of the observations therein made apply with equal force to the present edition. There can be no doubt as to the care and accuracy of the observations recorded, and of the value of the methods which the authors have introduced. Whether in all particulars they are correct in the interpretation of their results is a question upon which pathologists are still divided. No one will, however, doubt that both volumes form a valuable contribution to the physiology and pathology of the blood.

MINERALOGY.

The World's Minerals.—By LEONARD J. SPENCER, M.A., F.G.S. 212 pages. 61 illustrations. 8½-in. × 5½-in.

(W. & R. Chambers. Price 5/-.)

The author of this book is an official of the Mineral Department of the British Museum and is the editor of the *Mineralogical Magazine*.

In 1904 he translated from German into English, the beautiful work upon precious stones by Dr. Max Bauer of the University of Marburg, and also made certain additions to the text. We believe that the English edition of this work is now out of print.

In the preface to "The World's Minerals" the author tells us that the book deals with one hundred and sixteen of the more simple minerals, which are illustrated by one hundred and sixty-three figures in the coloured plates, and that mention also is made of the various applications of minerals, their importance as ores of metals as precious stones, and so on.

We are sure that the information given of the various minerals is in every way correct, especially considering the position which the author has so long occupied and the work which he has previously done. We find, however, that in some cases the descriptions are so meagre as to be somewhat misleading.

As an example of what we refer to we may quote Spinel, which is described as a red mineral occurring in the cubic system, which when cut as a gem somewhat resembles the ruby in appearance, but the author does not tell us that it also, in different specimens, is green, blue, brown and violet.

We also cannot quite understand why such a mineral as chrysoberyl, with its important gem-stone varieties, has been omitted.

On page 90 the author describes the fibrous variety of quartz as catseye, and refers the reader to an illustration stated to be made from a specimen from Ceylon. Now, the beautiful catseyes of Ceylon are a variety of the mineral chrysoberyl, and they rank among the most important precious stones, while the chatoyant quartz is a stone of quite minor consideration, commercially, and in every other respect, although it slightly resembles the chrysoberyl catseye in general appearance. The writer does not explain th[illegible] it apparent that he is aware of the fact.

The book will probably be welcome, for it is written in such a clear manner that every student will be easily able to understand it.

The coloured plates are very numerous and add considerably to the value of the work. They have been prepared under the supervision of Dr. Hans Lenk, Professor of Mineralogy and Geology in the University of Erlangen, and many of the pictures represent actual specimens belonging to the collection under his charge.

Here and there we take exception to a shade of colour, but this is probably due to the process of reproduction.

In the early pages of the book the author gives an introduction to the study of minerals which will be most helpful to the student.

Chapter 2 is devoted to "The Forms of Minerals," and we notice here that crystals are classified under seven systems and not six as is customary, and we rather wish the author had given us his reason for doing so.

The book has an excellent index, which appears to be reliable.

PHYSICS.

Physical and Chemical Constants and some Mathematical Functions. By G. W. C. KAYE and T. H. LABY. 153 pages. 9¾-in. × 6¾-in.

(Longmans, Green & Co. Price 4/6 net.)

The authors have compiled a most useful book of reference. It is remarkable how much is to be found in this thin book of one hundred and fifty pages. One can find within all the data which one is constantly requiring to look up during one's work in the laboratory, except, of course, the less common constants, which one could hardly expect to find even in Landolt Bornstein and Meyerhoffer's "Physikalisch Chemische Tabellen." For instance, one would find the boiling point of pentane but for the melting point, which is somewhere below − 200° C., one would have to search in some original paper.

The book is very concentrated, and as a reference book is therefore, all the more useful. It commences with the units, and passes on to astronomical data, then follows a very complete set of data in the subjects of heat, sound, and light. The section on radioactivity and gaseous ionisation is excellent and gathers much valuable work together in a set of excellent tables. The Chemistry section is necessarily rather curtailed, but the chief properties of all the commoner chemical substances are to be found in two tables of the physical constants of inorganic and organic substances. There is a short table of solubilities in water of a few common substances, but a complete solubility table requires a large book of its own.

The mathematical tables at the end, though only occupying eighteen pages, are those that are most generally needed and are very conveniently arranged. A table of the exponential e^{-x} will be very useful to students of radioactivity.

As far as one can judge, the tables are reliable and thoroughly up-to-date, while the recently-formed international committee for the yearly publication of physical and chemical constants will help to make it the easier to keep the book abreast of the times.

The value of the book is enhanced by brief references to books and original papers which have bearing on the various subjects under consideration.

The book is excellently got up and thoroughly suitable for the laboratory.

ZOOLOGY.

Primitive Animals. By GEOFFREY SMITH, M.A., Fellow of New College, Oxford. 156 pages. 25 figures. 6¾-in. × 4¼-in.

(Cambridge University Press. Price 1/- net.)

It was a happy idea on the author's part to give this introduction to the study of phylogeny a concrete and picturesque basis in a series of "primitive animals" or old-fashioned types, like Peripatus and Platypus, Anaspides and Amphioxus. "Relics of a distant past, the features of which have been all have attempted ... [illegible] from the ... [illegible] ... and other points ... [illegible] ... modern world ... [illegible] ... racial history ... [illegible] ... because of considerable ... [illegible] ... the early days of Darwinian enthusiasm ... [illegible] ... to the extent of leaving the doctrine of descent ... out of abstract formulæ of evolution ... which ... no doubt occurred, but of ... [illegible] ... all is so uncertain. Mr. Geoffrey Smith ... of the extreme sceptics as to the possibility of phylogenetic conclusions, for though he does not think that we can speculate to good purpose in regard to the inter-relationships of phyla, he believes that within the limits of the great groups "comparative morphology has supplied us with a number of securely founded generalisations of real value." To students who wish to turn from the abstract discussion of "factors of evolution" to the concrete problems of affiliation—and there should be many of this mood—this little book will be a welcome guide. It is very fresh and interesting, its scientific temper is in itself educative, it is full of what we venture to call morphological suggestiveness. The first chapter gives an outline of the great series or phyla of animals; the second discusses beginnings—among Protozoa and Protophyta; the third treats of the great Appendiculate phylum (which seems to us very top-heavy); the fourth is a wise discussion of the relation between individual development (ontogeny) and racial evolution (phylogeny); the fifth deals with the ancestry of the vertebrates, the sixth with the possession of the dry land, and the seventh with the rise of mammals. The last chapter of reflections, which stretches the title of the book to the breaking-point, may be regarded, we hope, as the bud of another book as good as this one.

J. Arthur Thomson.

The Natural History and Antiquities of Selborne, in the County of Southampton. By Gilbert White. With ... [illegible] in colour by George Edward Collins, R.B.A. 476 pages. ... in. × 10-in.

(Macmillan & Company. Price 10s. 6d. net.)

There are still a number of people who are interested in Natural History who have yet to experience the pleasure and ... of reading Gilbert White's masterpiece. To them we recommend the new quarto edition of the Natural History of Selborne which Messrs. Macmillan & Company have recently published. It is a faithful reprint of the work of "The Naturalist's Calendar, with observations in various branches of natural history," which Dr. John Aikin extracted from the "Naturalist's Journal" kept by Gilbert White from the year 1768, to the time of his death in 1793. This journal and the Garden Calendar, which he kept previously, and began in the year 1751, are now in the British Museum. There are many of those who know "The Natural History of Selborne" who will welcome the opportunity of renewing their acquaintance with it by means of the readable edition under review, which has wide margins and is illustrated by a number of sketches by George Edward Collins, reproduced by the three-colour process. The effect which the work of Gilbert White has had on the study of Nature in this country is very great; for his observations had great influence on many prominent naturalists, including Charles Darwin, and it is most fascinating to read how the country curate differentiated between the Willow Warbler, Chiffchaff, and the Wood Warbler; how he recorded for the first time the occurrence of the minute Harvest Mouse and its ball-like nest; or how, again, he sought for evidence in favour of the old theory, now long exploded, that swallows hibernate in winter.

THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS.

The Twelfth Annual Meeting of the Association of Public School Science Masters was held at the London Day Training College, on January 10th and 11th. The President this year was Sir J. J. Thomson, F.R.S. He urged the necessity of a proper use of text books, and pointed out that although the students who come up to learn Physics at the Cavendish Laboratory were no longer deficient in mathematical knowledge and the classes specially held for their benefit in this subject were being discontinued, there was a very small proportion who could translate a passage from German into English. Considerable discussion was raised by Mr. Matthew Davenport Hill's paper on "The Value of Chemistry and Physics as an Introduction to Biology." School Biology meaning Morphology, Mr. Hill did not think a training in more exact science should necessarily precede it, and we remember Mr. Ashford, when he was at Harrow some years ago, urging in an educational conference that Natural History was the best introduction to science for young children, for they all had some amount of interest in living things, whereas Physics and Chemistry were quite new to them. The great advantage of teaching Plant Biology in a school was instanced by Mr. F. L. Lewis, of Oundle. Mr. C. E. Ashford, of The Royal Naval College, Dartmouth, discussed the place of Electrostatics in a science course, while papers were read on the teaching of Qualitative Analysis and on Educational Pschology, the latter by Mr. A. Vassall, of Harrow.

As usual there was an exhibition of scientific apparatus and books. Messrs. Philip Harris & Co., of Birmingham, showed a full series of Galvanometers, Theodolites and so on as well as a novelty in the shape of a cheap stop-clock, working models of a chemical laboratory bench; verniers and spherometers were exhibited by Messrs. Baird & Tatlock; while on the stand of Messrs. F. E. Becker & Company was a novelty in the shape of a compact set of wireless telegraphic apparatus which will work over a distance of two miles. Another noteworthy exhibit by this firm was a liquefaction apparatus which will liquefy sulphur dioxide or ammonia.

Messrs. Brown & Sons staged a number of stills of various patterns, in addition to examples of their well-known apparatus for physical work. Messrs. Cussons had on view a new arrangement for finding the force of gravity designed by Mr. Mott, of Giggleswick, and consists of a free-falling plate with an electrical release. The model of this, we believe, was exhibited last year amongst the apparatus designed and shown by members of the Public School Science Masters' Association themselves. We may mention also that Messrs. A. Gallenkamp & Co. are well-known as balance-makers and their physics apparatus is also worthy of mention. Messrs. Reynolds & Bransome, of Leeds, showed a number of new accessories used with Stroud and Rendell's science lantern for demonstrating the laws of optics, and the "Rystos" optical bench for attachment to the same lantern.

Among the novelties which might be picked out from the large series contributed by Messrs. Townson & Mercer we may speak of Blackman's improved rapid filter, which depends for its success on the fact that the cone of the filter paper does not come into contact with the glass of the funnel. Allusion may also be made to their vacuum filters.

Microscopes and accessories were shown by Messrs. W. Watson & Sons, and for the description of a new microscope demonstration table we refer our readers to our Microscopical Column.

An opportunity was afforded to those who visited the exhibition of seeing the latest books on science brought out by the Oxford and Cambridge and Tutorial Presses as well as by Mr. Edward Arnold, Messrs. George Bell, Messrs. Macmillan and Messrs. Methuen.

In the members' section was shown a modified form of Fletcher's apparatus by Mr. D. P. Berridge, of Malvern. By a judicious introduction of metal, the wear and tear which is a drawback to the wooden form has been avoided as well as the great weight which results when the apparatus is made entirely of iron. Messrs. Cussons, who are putting this apparatus on the market also showed an example of it. An ingenious way of making model volcanoes was demonstrated by Mr. G. H. Martin, of Bradford.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

METEORS.—An important paper on meteors has been published by Charles P. Olivier in the *Transactions of the American Philosophical Society*. He has discussed the observations of six thousand five hundred meteors seen between 1898 and 1910, and deduced one hundred and seventy-five parabolic orbits: a great many were observed by himself at the Lick Observatory. He makes an absolute rule that radiants must only be determined by combining observations made on the same night, and says that neglect of this rule has led to the deduction of many fictitious radiants. Most of the meteors were seen in July, August, October, November; several in January, April, May, a few in December. There were no observations in February, March, June, September.

The first shower discussed is the Aquarids, of which good observations were obtained on 1910, May $5^d·0$, $6^d·9$, $12^d·0$ G.M.T. The radiants at the three dates were: (1) 334°·0 − 3°·4, (2) 337°·7 − 0°·6, (3) 342°·0 0°·6. The parabolic orbits, and the orbit of Halley's comet, are given below, also the orbit of the Orionids (4).

	ω	Ω	i	q
(1)	111°·0	44°·1	166°·2	·677
(2)	102 ·3	46 ·0	163 ·2	·607
(3)	104 ·3	50 ·8	166 ·7	·630
(H)	111 ·7	57 ·3	163 ·2	·587
(4)	87 ·8	25 ·6	161 ·4	·536

The connection of the meteors with the comet is considered established, but they have spread out greatly from the comet's orbit. In fact, a cylinder of radius thirteen million miles appears to be filled with them. It seems not impossible that the Orionid Stream may also have a connection with the comet, meeting the Earth near the other node of the orbit. The connection, however, is far more doubtful than in the case of the Aquarids. The Perseids and the October streams are fully discussed, the latter being shown to consist of a main stream and a number of minor ones, with radiants separated by several degrees. It is suggested that these minor streams had the same origin as the great stream, but have been gradually separated from it. He does not accept the stationary position of the Orionid radiant, but finds evidence of an eastward motion. He doubts the reality of stationary radiants in other cases also, and follows Bredichin in the view that they are composite. Of the one hundred and seventy-five orbits only twenty-seven are direct, but this arises from the greater chance of our meeting a meteor moving in the reverse direction to the Earth, just as more trams pass a pedestrian in the opposite direction to his motion. Twenty-eight perihelia lie in the first quadrant of longitude, sixty-six in the second, sixteen in the third, fifty-five in the fourth.

He notes as evidence of the clearness of the atmosphere at Mt. Hamilton that most of the meteors seen there are of the fourth magnitude, while in Virginia those of the third magnitude predominated. Yellow meteors have the shortest time of visibility, red and orange longer, green and white longest.

GROUPS OF STARS WITH COMMON DRIFT.—Several groups of stars that seem to be travelling in company have now been recognised. The best known is the Ursa Major group, to which Sirius was recently added. There is a group in Taurus, and one in Perseus. Mr. Benjamin Boss (*Astron. Journ.* No. 629) makes a notable addition to the list, having detected a group of stars with large proper motions, which appear to be moving, with equal velocities, on nearly parallel lines. The following is the list of stars. Their convergent point is R.A. 6^h 17^m, N. Dec. 0°·5. The observed and computed position angles of the motion of each are given; it will be seen how closely they agree. μ is the Proper Motion in a century.

Star.	For 1875. R.A.	For 1875. Dec.	μ	Pos. Angle. Obs.	Pos. Angle. Comp.
Pi. O. 130	0 31	S 25°·4	130"	90°	90
Pi. I. 142	1 34	N 42 ·0	82	100	99
δ Triang.	2 9	N 33 ·7	118	102	103
Greenw., 1860, 284	3 55	N 35 ·0	221	128	124
λ Aurig.	5 10	N 40 ·0	84	141	147
π Mensae	5 47	S 80 ·6	109	11	13
Pi. VII. 321 ...	8 4	N 32 ·8	81	215	217
Lal. 4887	11 41	S 39 ·8	157	284	279
61¹ Cygni	21 1	N 38 ·1	525	52	49
61² Cygni	21 1	N 38 ·1	515	54	49
ε Indi	21 54	S 57 ·3	470	124	126
ν Indi	22 14	S 72 ·9	145	119	124

To test the matter further, Mr. Boss examined the radial motions, as far as these are available. The linear velocity of the group relatively to the Sun is ninety-five kilometres per second. With the exception of the second star (which possibly does not belong to the group) the results are surprisingly harmonious, and leave no doubt of the reality of the common drift.

The computed and observed parallaxes are also compared. In several cases there is good accordance: in the case of the smaller parallaxes the observed values are uncertain. The stars are in the same order as in the first list.

No.	Radial Vel. Obs.	Radial Vel. Comp.	Parallax. Obs.	Parallax. Comp.
	km	km		
1		2	0"·36	·07
2	+ 5	+ 18	·12	·04
3		+ 32	·12	·06
4		+ 60	(·01)	·14
5	+ 66	+ 70	·11	·06
6	+ 12	+ 14		·06
7		+ 75	·05	·06
8	+ 18	+ 17		·08
9	62	64	·31	·34
10		60	·31	·34
11	39	34	·28	·25
12		18		·07

I have already alluded to Mr. Eddington's paper on "Star distribution" at the British Association. One interesting point that he brings out is that the actual frequency of stars of different spectral types may be very different from their frequency in our catalogues. Thus, in his list of the seventeen nearest stars three are of the type denoted by Ma, whereas in our catalogues only one star in fifteen is of this type.

The Orion or Helium type (denoted by B) is commoner in the catalogue than Ma, but none appear among our nearest neighbours. He gives as the explanation that Ma stars are really pretty common everywhere, but, being intrinsically very faint, cannot be seen at great distances, while the Helium stars are very rare, but being of extreme brilliance are visible at immense distances. This is confirmed by the failure to detect sensible parallax in such stars.

[illegible] E. Hertzsprung [illegible] N. Dec. [illegible] it parallel [illegible] elevent[illegible] position [illegible] in 1864 [illegible] these had changed to [illegible]. The [illegible] of the companion [illegible] magnitude [illegible] of the same surface [illegible] comparable with Jupiter [illegible] colour and Ma spectrum; the [illegible] and doubtless in spectrum. It will be long before [illegible] of the orbit has been described to determine the [illegible] of the two stars. They may differ [illegible] less than the luminosities, as in the cases of Sirius and Procyon.

SCHAUMASSE'S COMET.—The following ephemeris of this comet is from later elements, and therefore more accurate than the one given in the "Face of the Sky." It is for Paris midnight.

	R.A.	S.Dec.		R.A.	S.Dec.
	h. m. s.	° ′		h. m. s.	° ′
Feb. 6	16 15 28	3 51	Feb. 22	16 40 13	4 22
„ 10	16 22 27	4 2	„ 26	16 45 8	4 25
„ 14	16 28 50	4 11	Mar. 1	16 49 30	4 27
„ 18	16 34 46	4 17	„ 5	16 53 18	4 27

ERRATUM LAST MONTH.—In the table of errors of Encke's Comet, insert the word "*minus*" between "Observed" and "Computed."

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

MUTATION IN SHEPHERD'S PURSE.—From time to time more or less strikingly abnormal forms have been described in the widespread and very variable Shepherd's Purse. For instance, in 1886 (*Bot. Centralblatt*, Band 26, page 121), Wille pointed out that various earlier observers had described abnormal forms of such Crucifers as Wallflower and Charlock, which had more than the usual number (two) of carpels, the number in some cases being as great as six, but more often four. In some Crucifers there are normally four carpels, and a four-valved fruit, e.g. *Holargidium* and *Tetrapoma*. Wille had seen, in 1885, a single Shepherd's Purse plant with three abnormal fruits which had three, four, and six wings respectively. The three-winged capsule had three valves, one complete and one incomplete partition, and six rows of seeds; that with four wings had four valves, two complete partitions, and eight rows of seeds; while that with six wings consisted of an ordinary two-valved fruit fused with a four-valved one, the stigmas being separate.

In 1900 (*Bot. Zeitung*, Band 58), Solms-Laubach described a form which may be regarded as having arisen by mutation from the common Shepherd's Purse (*Capsella bursa-pastoris*). This new species (*Capsella heegeri*) had appeared suddenly and spontaneously, and on being cultivated for several years retained its characters, that is, bred true from seed. It is an annual plant, like ordinary Shepherd's Purse. Excepting for the structure of its fruit, *C. heegeri* resembles a variety of *C. bursa-pastoris* with the radical leaves pinnately cut. The capsule, however, is egg-shaped, showing neither the flattening nor the two humps characteristic of *C. bursa pastoris*, and has at its base a short thick stalk. Solms regards this new species as having arisen by mutation from *Capsella bursa pastoris*, since its characters are constant and the fruit is widely different—sufficiently so, in fact, to justify its being placed in a new genus.

Shull (*Proc. Int. Zool. Congress, Boston*, 1907; published in 1910; abstract in *Bot. Centralblatt*, Band 116, 1911) isolated four [illegible] elementary species of *Capsella bursa-pastoris* [illegible] found that they [illegible] Mendelian [illegible]. Reciprocal [illegible] between *C. heegeri* and the [illegible] elementary species of *C. bursa-pastoris*. In the [illegible] elementary species of *C. heegeri* were produced, [illegible] of the hybrid [illegible] Mendelian [illegible] the *heegeri* capsules appearing [illegible] about one [illegible] hundred and twenty-three of the second [illegible] generation.

Blaringhem (*Bull. Sci. France et Belg.*, 1911) [illegible] described another new form of *Capsella*, a single specimen of which was found growing among abundant *C. bursa pastoris*. This history of this new species (*C. viguieri*) parallels that of *C. heegeri*, but *C. viguieri* shows a variation of the capsule in the opposite direction from that presented by *C. heegeri*. The great majority of the capsules have four valves, resembling the two valves of *C. bursa pastoris* and placed at right angles to each other, but the number of valves varies from two to eight. Counts of nearly ten thousand fruits showed: Two-valved, 2; three-valved, 81; four-valved, 8450; five-valved, 501; six-valved, 288; seven-valved, 24; eight-valved, 16. This new species is normally fasciated, and breeds true to this character as well as to the high number of valves. The leaves are almost entirely unlobed.

Solms, Blaringhem, and Wille (whose paper appears to have been overlooked by later writers on the subject, but has been consulted by the present reviewer) lay stress on the fact that several species of Cruciferae have four winged capsules. It is quite obvious that several species of *Tetrapoma* would, if two-valved, be classified as species of *Nasturtium*; the genus *Holargidium*, if two-valved, would be merged in *Draba*; while the Californian genus *Tropidocarpon* has one species with two valves and one species with four. Moreover, four-carpelled varieties, both cultivated and wild, are known in such genera as *Cheiranthus*, *Brassica*, *Isatis*, and other Crucifers. Such instances as these, of the recurrence of similar characters in more or less closely related species or genera, support the view that variation is definite, or "orthogenetic," rather than entirely fortuitous.

In reviewing Blaringhem's paper, Shull (*Bot. Gaz.*, June, 1911) remarks that mutations probably occur in Nature as frequently, in proportion to the percentage of the seeds which succeed in germinating and developing, as in experimental cultures, but actual proof of such mutation is necessarily wanting, as a rule. When a single individual of a hitherto unknown type is seen to differ by some marked characteristic from the associated typical individuals of the most closely related species, the natural inference is that the non-typical plant is a mutant. Such evidence is strengthened if the plant is found to reproduce its characteristics in its offspring, but there remains the question of possible hybridisation; and if even that be satisfactorily ruled out, there is the possibility that the form in question is not itself a mutant, but the offspring of a mutant, which appeared in some preceding generation. This last question cannot, of course, be cleared up in any case, but it is of no essential importance.

BROWN FLAGELLATES AND BROWN ALGAE.—Pascher has recently published two interesting papers (*Ber. d. deutsch. bot. Ges.*, 1911) dealing with Brown Flagellates and the relations of these to the Brown Algae.

In the first paper he gives a short account of two new genera of Brown Flagellates. *Cryptochrysis*, which was only observed in the motile state, resembles other Flagellata in having no cell-wall and in dividing by a plane parallel to the long axis of the body, which is an ellipsoid mass of protoplasm; the broader notched anterior end bears two whip-like flagella, and the protoplast contains two brown pigment bodies. *Protochrysis* is also ellipsoid but curved and bean-shaped, with two flagella inserted at the middle of the concave side; the chromatophores, two in number, may be reddish or bluish-green instead of brown; division occurs in a motionless condition, the cells rounding off, becoming surrounded by a swollen membrane and dividing into colonies of from four to eight cells.

The Flagellates included by Pascher under the family Cryptomonadinae are rather few, the most interesting (in addition to the two new genera just mentioned) being *Zoöxanthella* which lives in symbiosis with lowly animals like the Radiolaria. The Cryptomonads are distinguished from the other Flagellates, especially the Chrysomonads, by the remarkably dorsiventral or one-sided (as opposed to radial) symmetry of the body, which is obliquely truncated at the anterior end; the presence of a curious furrow, which is usually in the longitudinal plane but in *Protochrysis* is equatorial; the frequently red or blue tinge of the usually brown chromatophores; the unequal pair of cilia inserted in the furrow.

Starting from the simple Chrysomonads, these probably gave rise to the Cryptomonads, and the red and blue varieties of the latter then became fixed characters in the red genus *Rhodomonas*, which may be regarded as the direct Flagellate ancestor of the Red Algae, and in the blue-green genera *Chroomonas* and *Cyanomonas*, which may have given rise to the Blue-green Algae. A third line arising from the Cryptomonad group (e.g., *Cryptochrysis* and *Protochrysis*) passed through Cryptomonas, in which the apical furrow gradually becomes deeper and forms an "oesophagus" (a cavity which extends more or less deeply into the protoplast, and into which the contractile vacuole opens); this line of larger and more highly organised forms ends blindly in heterotrophic (saprophytic) genera like *Chilomonas* and *Cyathomonas*.

The most important line arising from the Cryptomonads, however, is that leading through the remarkable series of Phaeocapsaceae to the higher Brown Algae. The Phaeocapsaceae correspond, in the Brown Series, to the Tetrasporaceae in the Green Series leading from Green Flagellates to Green Algae. In the Phaeocapsaceae we get a series of forms passing almost insensibly from true Flagellates to true though simple Brown Algae. The first known member in this series is *Phaeoplax marina* (formerly called *Phaeococcus marinus*). In *Phaeoplax*, the motile reproductive cells exactly resemble *Cryptochrysis*, having the same dorsiventral symmetry and the same minute structure, but the plant passes the greater part of its existence in the motionless condition, dividing to form a mass of cells enveloped by mucilage derived from the cellulose walls (the Cryptomonads themselves have no cellulose walls). Through forms showing increasing suppression of the motile phase, and increasing elaboration of the cell-masses formed by division in the resting stage, we come to the genus *Phaeothamnion*, which forms branch filaments and produces sexual reproductive bodies (gametes)—sexual reproduction does not occur in the Cryptomonads or any other Flagellates so far as known.

Pascher's paper is an interesting contribution to the evolution of the Algae from Flagellates. The phylogeny of the Green Algae has been worked out in great detail (see Blackman's well-known paper (*Annals of Botany*, 1900)—but less is known concerning the relation of Brown Flagellates to Brown Algae, and still less regarding the Red and Blue-green Flagellates and Algae. Still, there seems to be little ground for doubting that the Brown, Red, and Blue-green Algae have arisen from some such Flagellate group as the Cryptomonads.

CLASSIFICATION OF BRYOPHYTA. At the end of a series of papers on "The Inter-relationships of the Bryophyta" in the *New Phytologist*, the present writer has proposed a new classification of this group of plants. The old-established primary division of the Bryophytes into Mosses and Liverworts is called in question, especially in connexion with the small families Anthocerotaceae and Sphagnaceae (Peat Mosses), and it is interesting to note that in certain of the characters which have been regarded as excluding the Anthoceros family from Liverworts on one hand, and the Sphagna from the Mosses on the other, these two aberrant groups show a striking resemblance to each other. After discussing the advisability of dividing the Bryophytes into four classes—true Liverworts, Anthocerotes, Sphagna, and true Mosses—the writer proceeds to elaborate a new classification. It is proposed to divide the Bryophytes into ten independent groups, as follows:

I. Sphaerocarpales, including Sphaerocarpaceae (*Sphaerocarpus* and *Geothallus*) and Riellaceae (*Riella*).

II. Marchantiales, including Ricciaceae, Corsiniaceae, Targioniaceae, Monocleaceae, Cleveaceae, Aytoniaceae, and Marchantiaceae.

III. Jungermanniales, including the Anacrogynous families Aneuraceae, Blyttiaceae, Codoniaceae; the transitional family Calobryaceae; and the Acrogynous families Lophoziaceae, Cephaloziaceae, Ptilidiaceae, Scapaniaceae, Radulaceae, Pleuroziaceae, Porellaceae, and Lejeuneaceae.

IV.—Anthocerotales, including Anthocerotaceae.

V. Sphagnales, including Sphagnaceae (*Sphagnum*).

VI. Andreaeales, including Andreaeaceae (*Andreaea*).

VII.—Tetraphidales, including Tetraphidaceae.

VIII.—Polytrichales, including Polytrichaceae and Dawsoniaceae.

IX.—Buxbaumiales, including Buxbaumiaceae and Diphysciaceae.

X.—Eu-Bryales, including all the higher mosses.

All these groups are characterised and their relationships discussed. The arrangement of the lower Bryophytes is based largely on the writer's own work, while for the higher mosses (Eu-Bryales) the writer accepts the views of Lorch, Philibert, and Fleischer, with some modifications.

The classification of the higher mosses can no longer be based upon such characters as the position of the fruit (the old groups Acrocarpi and Pleurocarpi) nor upon the presence or absence of a peristome (Stegocarpi and Cleistocarpi of previous authors), though the various terms—acrocarpous, pleurocarpous, stegocarpous, cleistocarpous—may be retained for purely descriptive purposes. In the new classification of mosses proposed by the writer, the Eu-Bryales are divided first into *Haplolepideae*, *Heterolepideae*, and *Diplolepideae*, according to the single or double character of the peristome, and the various cleistocarpous forms are simply distributed through these groups according to what appear to be their affinities as either reduced or primitive types allied to different peristome-bearing families. The further division of the great group Diplolepideae is based upon minute, but readily observable, differences in the structure of the peristome.

Throughout this series of papers, it is assumed as a working theory that the Bryophyta form an ascending series, marked by progressive elaboration of the sporophyte; that the sporogonium of the Bryophyta has arisen as an interpolated generation, with increasing "sterilisation of potentially sporogenous tissue," from the segmented oöspore; that although the archaic condition in which the sporogonium was a simple spore-fruit consisting of a mass of sporogenous cells, is not actually realised in any known Bryophyte, we have in the *Riccia* capsule a primitive sporophyte in which sterilisation has proceeded only as far as the formation of a single peripheral cell-layer forming the capsule-wall; and that the *Riccia* type of sporogonium is not only the simplest but also the most primitive known.

This theory has been much disputed, but at any rate the question is apparently still an open one. The writer's object in this series of papers has not been so much to discuss the position of the Bryophyta as a whole and its relations to other divisions of the Vegetable Kingdom, as to give a summary of the various families of Mosses and Liverworts and of their relations one to the other.

The "Inter Relationships of the Bryophyta" is obtainable separately, as a "*New Phytologist* Reprint," from the Editor of the *New Phytologist*, Botany School, Cambridge University (price 4s., postage 4d.); it contains numerous illustrations and full lists of the literature of Mosses and Liverworts.

CHEMISTRY

By C. A[illegible] Mitchell, B.A. (Oxon.), F.I.C.

PRODUCTION OF SOLID OXYGEN.—Sir James Dewar [illegible] succeeded in solidifying oxygen by [illegible] been done in the case of hydrogen and [illegible] he gives an account of his [illegible] (*Proc. Royal Soc.*, 1911, A, LXXXV, [illegible]). [illegible] oxygen was placed in an isolated [illegible] at about the temperature [illegible] the element solidified to a transparent [illegible]. The melting point of solid oxygen, which was determined by means of a hydrogen thermometer, was found to be [illegible].

ALCOHOL FROM WOOD WASTE IN SWEDEN.—Although it is many years since the conditions for producing alcohol from sawdust were ascertained, most of the factories established for the purpose have met with but little commercial success. Recently, however, the economic problem has been attacked from another side in Sweden, and an interesting account of the new industry is given by Mr. T. H. Norton, in a Consular report to the United States Government.

In the preparation of cellulose from wood the waste sulphite lyes contain about fifty per cent. of the wood originally introduced into the boilers; and since about ten tons of residual lye are left for each ton of cellulose made by the process, the profitable utilisation of this waste material has long been an industrial difficulty. These waste lyes contain various sugars, including dextrose (glucose), together with acetic acid, nitrogenous compounds, tannins, and the calcium lignin-sulphonate, which is the main product formed in the reaction.

The sugars, most of which are fermentable, constitute about one per cent. of the lyes, and it is from them that the alcohol is produced. The liquid is first neutralised by the addition of calcium carbonate and then fermented in the usual way by the addition of yeast. The resulting spirit is separated by distillation and concentrated by redistillation as in the ordinary process of manufacture, and about six gallons of one hundred per cent. alcohol are thus obtained from each one thousand gallons of lye, or about fourteen gallons for each ton of cellulose.

This crude alcohol, which contains methyl alcohol and other impurities, is used for various technical purposes, such as heating, varnish making, and so on, and the Swedish excise duties have been modified in its favour. If alcohol were manufactured in this way from all the sulphite works in Sweden, there would be an annual output of three million five hundred thousand gallons, but Mr. Norton doubts whether Sweden could utilise this quantity of the crude product. About eight hundred thousand gallons of alcohol could be made in the same way from the waste lyes of the sulphite works in Germany, provided that the economic conditions were suitable; but this, in the opinion of German chemists, is open to question.

In the direct preparation of alcohol from wood the finely divided material is treated with dilute sulphuric acid under pressure, so as to cause partial hydrolysis of the cellulose, with the formation of dextrose. The liquid is filtered, neutralised, and fermented with yeast, and the alcohol separated by distillation. Mr. Norton states that about fifteen per cent. of alcohol may be obtained from pure cellulose, and from five to six per cent. from ordinary wood.

THE COMPOSITION OF SOOT.—The chemistry of soot is dealt with in a paper read before the Society of Chemical Industry, by Professor Cohen and Mr. A. G. Ruston (*J. Soc. Chem. Ind.*, 1911, XXX, 1360) and their results afford much valuable information to the agriculturist. Soot consists chiefly of carbon, tar, and mineral matter, with smaller proportions of sulphur and nitrogenous compounds, and frequently has an acid reaction. The proportion of the various constituents varies greatly with different factors, such as the nature of the coal, the completeness of combustion and the distance from the fire at which the soot was deposited.

Compared with ordinary [illegible] the product from factory boilers is poor in carbon and volatile products, [illegible] tar and ammonium salts, and contains much [illegible]. The nearer the base of the boiler chimney, the more pronounced the difference, since the high temperature prevents [illegible] deposition of the volatile products. This is illustrated by the percentage results of various analyses [illegible] the following are typical:

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Speaking generally, the proportions of nitrogen, sulphur and chlorine in boiler soot increase with the height of the deposit in the chimney, whereas in the case of domestic soot there is a decrease in these constituents. The value of soot as a fertiliser depends partly upon its physical action in causing a greater absorption (by reason of its dark colour) of the sun's rays, and thus raising the temperature of the soil. It also helps to lighten heavy soils, while the presence of the sulphur accounts for its action in preventing the approach of slugs.

Its manurial value depends upon the small proportion of ammonia or ammonium salts which it has absorbed from the volatile gases in the chimney. Taking the value of nitrogen in fertilisers as about twelve shillings per unit, or sixpence per lb., the value of domestic soot may vary from about 24s. to £5 per ton, since the nitrogen in such soot ranges from about two to eight per cent. The usual price paid for soot is £2 to £3, so that the customer may or may not be purchasing cheaply.

Although it is not possible to determine the proportion of nitrogen by any simple method, it has been found that the more springy and bulky the soot, the greater the proportion of nitrogen, and consequently the manurial value. A good domestic soot ought not to weigh more than twenty-eight lbs. to the bushel, and it is recommended that the purchaser should stipulate that the consignment shall contain at least four bushels per hundredweight.

With regard to the loss of coal carbon as soot, experiments made by various chemists have shown that this amounts to at least six per cent. of the weight of the coal in domestic fires, and to about five per cent. in factory furnaces. On this basis, the annual minimum loss of coal in the form of soot in the United Kingdom is estimated to be two million four hundred and twenty thousand tons.

The proportion of soot deposited over a given area may be estimated by determining the solid impurities deposited after a fall of snow, and by a determination of the solid matter carried down by the rain. Experiments made in both ways have shown that the average deposit of soot over the whole of Leeds corresponds to at least two hundred and twenty tons per square mile in a year.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

ORIGIN OF RADIOLARIAN CHERT.—Many radiolarian cherts have hitherto been regarded as of deep-sea origin. Their exceeding fineness of grain, freedom from terrigenous material, and the abundance of their characteristic organisms has led to their identification as fossil representatives of sediments similar to the radiolarian oozes of the present ocean depths. Many observers, however, have pointed out that radiolarian cherts are frequently associated with shallow-water deposits. Their freedom from any but the very finest terrigenous material has militated against the view that the cherts themselves are of shallow-water origin. Mr. E. E. L. Dixon, in discussing the radiolarian cherts of the Carboniferous Limestone of Gower, Glamorganshire (*Q.J.G.S.*, November, 1912), gets over the difficulty by concluding that their deposition took place, together with other fine-grained deposits, in still and semi-isolated lagoon waters. Four lagoon or *Modiola*-phases are recognised in the Avonian of Gower. By a lagoon-phase is meant a series of rocks whose characters show that they have been deposited in coastal areas of wide extent, but so extremely shallow as to have become effectively isolated from the neighbouring deeper parts of the sea, and thus the sites of peculiar types of sediment and fauna. Three of these lagoon-phases are calcareous, and besides typical shallow-water deposits such as oolites, ostracod-beds, and beds containing fragments of contemporaneous sediments, they contain peculiar rocks consisting mainly of very fine-grained homogeneous limestones ("chinastone-limestones"), landscape marbles, and calcite-bearing mudstones. These rocks are all distinguished by a uniform fineness of grain, which suggests that their deposition was an exceedingly slow and gentle process. The fourth and uppermost lagoon-phase in Gower, consists of radiolarian cherts interbedded with laminated shales containing a few shallow-water lamellibranchs and plant fragments. From this association is inferred a shallow-water origin for the cherts, which view is supported by several lithological features. The cherts are banded or laminated, the laminae differing in the proportion and nature of their detrital material. Many of the laminae are decidedly lenticular or wedge-bedded. This points to the play of gentle currents laden with various fine sediments. It is also shown that radiolaria are not exclusively deep-sea organisms, but are found at all depths. Moreover, lagoon conditions would be favourable to their development, provided that the salinity of the water was not greater than that of ordinary sea-water, a condition that would be supplied by the proximity of a river.

PILLOW LAVAS IN THE DALRADIAN SCHISTS.

Pillow lavas associated with the Loch Awe group of the Dalradian Schists are described in a recently issued Memoir of the Geological Survey (Sheet 28, Knapdale). These occur in the Tayvallich peninsula of the Knapdale district of Argyllshire. Their successful study has depended on the low grade of metamorphism in the Tayvallich peninsula. The degree of metamorphism of the schists gradually decreases in a direction across the strike from south-east to north-west, and also along the strike from north-east to south-west. The minimum of metamorphism is attained in the Knapdale district, where the rocks are little more than cleaved. The quartzites of the Loch Awe group are now considered to pass under the limestone and slate division, whereas, beforehand, on the evidence of certain conglomerate bands, the reverse was supposed to be the case. The evidence for this change of opinion has been obtained mainly from the study of the associated pillow-lavas. In several places the latter form pillow-shaped masses exactly similar to those developed at Ballantrae (Ayrshire), Cornwall, and other British localities. They are slaggy, vesicular, and intercalated with thin beds of ash, black slate and limestone. The striking contrast between the tops and bottoms of the lowermost flows has provided the clue to the true stratigraphical succession in the district. The second lava of the type section in the bay to the south of Port-an-Sgadain gives most conclusive evidence that the whole series is "right side up." The base of this flow conforms exactly to the bedding of an underlying thin seam of dolomite, and is characterised by large steam-tubes ("pipe-amygdaloids") an inch in diameter, and reaching one foot in length. These are set at right angles to the base of the lava, and were probably caused by the uprise of steam from the moist sediment below. The interior of the flow contains parallel bands of spherical vesicles, and it is overlaid by a thin dolomite which fills up all irregularities, and does not appear "baked." As the lavas are interbedded with limestone, and underlaid by black slate and quartzite, the inference is that the order named is the true descending order of succession. Similarly, the Loch Awe group is underlaid, in the same descending succession, by the Ardrishaig Phyllites, still "right-way-up." The Tayvallich pillow-lavas thus provide a most striking clue to the true succession in the complicated district of the south-western highlands.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended December 23rd, as set out in the Weekly Weather Report issued by the Meteorological Office, was mild and wet, with thunderstorms in Scotland on the 17th, and in Ireland on the 17th and 18th.

Temperature was much above the average in all Districts, the excess reaching 6°·0 in England, E. The highest maximum was 58° at Hawarden Bridge, but 57° was reported at places as far apart as Glencarron, Dublin and Jersey. The lowest of the minima was 25° at Balmoral. At many stations, however, no frost was observed, and in the English Channel the temperature did not fall below 43° during the week. The lowest reading on the grass was 20° at Crathes and Newton Rigg.

Rainfall was also in excess in all Districts, and was very greatly so in many cases. Thus, in England, S.E., the total was more than four times, and in the Midlands more than three times the usual amount. At most of the stations rain was measured on each day of the week. There were, however, no exceptionally heavy falls, the greatest amount reported on one day being 1·07 inches, at Plymouth on the 20th, and at Crieff on the 23rd.

In spite of the rainfall the sunshine was in excess in Scotland, N. and E., and in Ireland, N. In the other districts, however, it was normal, or in defect. The highest aggregates were 14·1 hours (31%) at Nairn, and 14·7 hours (29%) at Birr Castle. At Westminster, the total was only 0·9 hours (2%). The mean temperature of the sea water varied from 41°·7 at Kirkwall to 49°·8 at Salcombe.

The week ended December 30th was also mild and wet, with thunderstorms at Bournemouth on the 24th, and at Tunbridge Wells, Cardiff and Markree Castle on the 25th.

Temperature was above the average in all districts, the greatest excess being 6°·0 in England, S.E. Maxima exceeding 50° were reported from all the districts except Scotland N., where the highest reading was 49°. The highest of the maxima, 56°, was reported at Bawtry, Blacksod Point and Killarney. The lowest readings recorded were 26° at West Linton, and 28° at several stations. In England, E., the minimum was 32°, and in the English Channel it was 40°. On the grass, minima down to 20° (at Newton Rigg) were reported.

The rainfall was again in excess, except in Ireland, S., where it was just normal. The differences from average were, however, in no case very large. At some stations in England, N.E., the amounts were quite small, under 0·2 inch, although made up of amounts on five or six days. At Glencarron, on the other hand, the total for the week rose to 5·62 inches, or half as much again as usual.

Sunshine was deficient except in England, N.E., where it was normal. The greatest deficiency was in the Western districts, and at Dublin the total for the week was only 0·6 hours or 22% below the average. In Westminster, the total was 2·4 hours (5%).

The mean temperature of the sea water ranged from 41°·2 at Burnmouth to 49°·8 at Salcombe.

The New Year opened with a continuance of dull, wet weather. Aurora was observed at Gordon Castle on the 5th, and a thunderstorm at Jersey on the 6th, on which day, in the Northern districts, snow and sleet were generally experienced.

Temperature was still above the average in all districts, the excess reaching 6°·3 in the Midlands and England, S.E. The maxima exceeded 50° in all parts and rose to 56° at Leith and Hawarden Bridge on the 1st. At no station was the maximum for the week reported as less than 49°. The lowest reading for the week was 27° at Poltalloch, on the 5th, but at quite a number of stations the temperature did not fall to freezing point, and at some it did not fall even to 40°.

Rainfall was in excess of the average except in Scotland, E. and W., where it was slightly below it. The excesses however were not great, in spite of the fact that at a few stations large aggregates were reported, up to 5·13 ins. at Glencarron.

[illegible] at Salcombe. [illegible]

The temperature [illegible] the average, and [illegible] to 50° at Salcombe. [illegible]

The [illegible] weather [illegible] parts of the country.

Temperature [illegible] of late, but was still [illegible] the [illegible] except in England, N.E. [illegible] the maximum did not exceed 54°, which was reported at a number of stations in different parts of the country, [illegible] stations as far north as Strathpeffer.

Frost was experienced in all districts except the English Channel. In Scotland, [illegible] of 14° were reported at West Linton, and [illegible] at Balmoral. On the grass, readings still lower were observed, down to 10° at Balmoral, 12° at Buxton, and 13° at Glasgow, and Newton Rigg.

Rainfall was below the average in Scotland, N., England, S.E., and the English Channel, but was above it elsewhere. In Ireland the total for the week was more than double the usual amount. There was heavy snow in Scotland on Monday; at Crieff it was 10 inches deep, and at Crathes when melted it yielded 1·78 inches of rain.

Sunshine was deficient in the Eastern districts, but was in excess in most of the Western districts. The daily average for the district varied from 0·8 hours (10%) in the Midlands and England, S.E., to 1·8 hours (23%) in Ireland, S. Dublin was the sunniest station, with a daily average of 2·1 hours (28%). At Westminster the average was 0·6 hours (8%).

The temperature of the sea water was above the average at most places. The mean values varied from 40·[illegible]° at Scarborough to 49·0 at Scilly.

MICROSCOPY.

conducted with the assistance of the following microscopists:

[illegible] | ARTHUR EARLAND, F.R.M.S.
[illegible] | RICHARD T. LEWIS, F.R.M.S.
[illegible] | CHAS. F. ROUSSELET, F.R.M.S.
[illegible] | D. J. SCOURFIELD, F.R.M.S.
[illegible], F.R.M.S.

THE SELBORNE SOCIETY'S CONVERSAZIONE.

The number of microscopes shown at the Annual Conversaziones of the Selborne Society is larger, perhaps, than at any other meeting nowadays in London. The next display will be on February 26th, in the offices of the Civil Service Commission, Burlington Gardens, New Bond Street, W., and any microscopist who would like to exhibit are requested to communicate with the Secretary of the Selborne Society, at 42, Bloomsbury Square, W.C.

SOOTY FUNGUS ON LEAVES AND ORANGES.

It must often have been noticed that towards autumn the upper sides of the leaves of many trees and shrubs become covered with a soot-like deposit. No doubt this is usually looked upon as merely dirt and dust which has collected on them during the summer. The commoner qualities of oranges frequently show the same thing, it being particularly evident near the place to which the flower was attached. Of course there is some dirt present in each case, but the appearance is generally largely due to a fungus growing upon the surface. If the leaf is allowed to dry slightly, the coating may be detached in flakes by carefully inserting the point of a knife under it. Some of the thinnest pieces should be soaked in spirit and [illegible] a little [illegible] may be added after [illegible]. On examination under the microscope [illegible] found that the [illegible] appearance represented in Figure 71, A. It [illegible] not [illegible] the leaf, but [illegible] its nourishment from [illegible] secreted by the [illegible] plentiful in [illegible], and which [illegible] the upper surface of the [illegible] the lower branches. [illegible] very little information [illegible] accessible to the ordinary microscopist, but the [illegible] mentioned and [illegible] are given in Dr. M. C. Cooke's "[illegible] Pests of Cultivated Plants," as *Fumago vagans* (Pers.). He says: "This black mould is familiar enough as [illegible] on the foliage of numerous trees in this country, and [illegible] such as are subject to honeydew. It forms black patches on the leaves to such an extent as to form a crust; but in this condition it is simply an imperfect fungus, and may develop into a species of *Capnodium* or *Meliola*, as the case may be." The specimens occurring on the orange may be treated in the same manner as the others, and it is usually easy to obtain flakes sufficiently large and thin for convenient examination if the fruit is somewhat shrivelled. Such a flake is represented in Figure 71, B. It will be noticed that the mycelium differs from that of the *Fumago*, being less moniliform and more filamentous in character, though there is much variety in various examples of both. In some cases a more advanced stage is present and perithecia may be found in considerable numbers. (Figure 71, C.) These are erect bodies, slightly thicker in the middle, almost like narrow tall bottles, sometimes branched, composed of threads of mycelium arranged side by side frequently with a spiral twist which is only evident under a high power. At the top the threads are separated and form a fringe round the mouth (fimbriated), while others spring from the sides and base forming a kind of undergrowth, among which the perithecia are situated. These filaments are much more thread-like than those composing the body of the plant, the cells are longer, lighter in colour, with the divisions between them far less distinct. Dr. Cooke says "genuine *sporidia* have never been found" but "minute sporules or conidia have been met with." These latter are plentiful near the specimens represented at Figure C, but are too small to be visible under the same magnification. The fungus also occurs on the leaves of orange and lemon trees in Europe, the United States, and Australia, frequently in sufficient amount to cause much damage. When present on the upper surface it must prevent the proper action of light on the chlorophyll, and when on both sides, as it is sometimes in the mango (*Mangifera indica*), it clogs the stomata and checks transpiration in addition. There is considerable uncertainty as to the life-history, and consequently correct classification of the varieties, but apparently when mycelium only is present and of the character represented at A, the fungus is looked upon as a *Meliola*, while when there are perithecia, with mycelium, as at B and C, some species of *Capnodium* is indicated. What is clear is, that all depend for their development upon the presence of honeydew or the excrement of aphides, scale insects, and so on, and that, though not directly parasitic, they cause much loss by hindering the vital functions of the plants on which they occur. The pretty little white four-winged "snowy fly" (*Aleyrodes*), closely related to the scale insects, which sometimes appears in vast quantities on cabbage plants as to constitute a pest, is often followed by an attack of sooty fungus. The figures are drawn from specimens mounted in glycerine jelly. That at A is from a leaf of Hedge Maple × 210; B and C are from an orange, B × 210, C × 40.

J. BURTON.

FIGURE 71.

A. M[illegible] B. M[illegible] [illegible] same.

LOW-POWER PHOTO-MICROGRAPHY FOR NATURALISTS. PART II.

Figure 72.

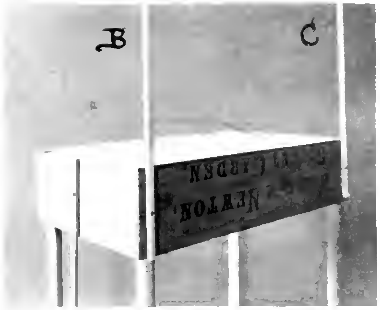


Figure 73.

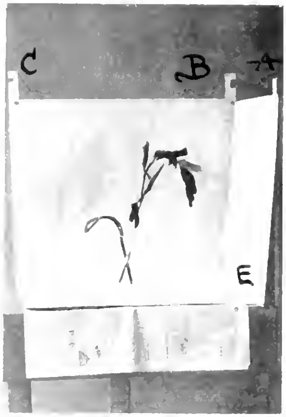


Figure 74.

The naturalist is frequently interested in photographing his subjects about three or four times life size, and wishes to secure results with the minimum exposure, so that the movement of the object may not spoil the picture. In this connection he will naturally seek the quickest plate, largest lens aperture, and most effective lighting scheme. With regard to the last named factor, much depends on being able to place and hold the object in good bright daylight. This brings us to the imperative need of a portable stand.

Figure 72 shows us a quite practical stand, made by turning an old packing case—a Covent Garden flower box, to be precise—mouth downwards, and fixing inside each corner a broomstick, by means of long screws from the outside, to serve as legs for the table. Next we take three round (penny) blind laths and get a flat side, by a stroke or two of a jack plane, to each lath. Two of them, B and C, (Figure 73), are fixed by one screw each to the back side of the table top, the third, A, to the centre of one end.

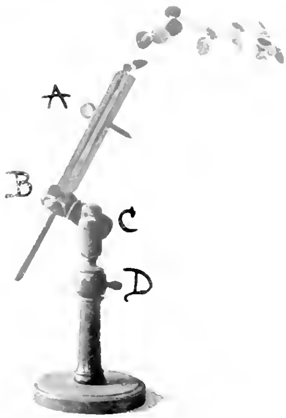


Figure 75.

The screw is just tight enough to enable the lath to turn on it as an axis, with the flat side of the rod against the box sides. The two laths at the back of the box are designed to support the card or paper backgrounds, while that at the end supports a white card reflector, *vide* Figure 74, where D, the background paper, is fixed by drawing pins to C and D, and E, the reflecting card (non-shiny), rests against A.

When the table is not in use it is safer to turn these three laths down, as we see A turned down in Figure 73.

For working in a room with a quite level floor one may use a four-legged stand, e.g., Figure 73; but with an uneven floor or when working out doors, it will be found better to rely on a three-legged stand such as is shown in Figures 72 and 74. In this case the legs should be of two-inch by one-inch quartering or something of that kind that is considerably heavier than broomsticks. The height of the table may conveniently be adjusted so that when the camera is on the tripod for use when one is

Figure 76.

Figure 77.

standing at two sides of the corner [illegible] on a level with the table top.

For background with the stand it is convenient to use a sheet of card [illegible] the two bars [illegible] at B [illegible] pins, and then attach a piece of tinted paper [illegible] paper [illegible] at the back [illegible] white, light and dark [illegible] backgrounds. The background paper should not have a glossy surface.

In immediate connection with this form of portable stand the question of holding such objects as botanical specimens when it is required to photograph, let us say, a small branch in the position in which it grows in nature.

One of the most useful tools is the familiar "universal holder" found in every chemical laboratory (see Figure 75). The cork-lined hinged jaws of the holding piece AB are adjusted by means of the screw at A to hold the specimen. B is another screw to hold the rounded end of AB. The joint at C is regulated by a third screw here, while D is another screw for holding a rod-like part sliding in the socket.

There are, however, many homely expedients of a simpler and cheaper character worthy of mention.

Turning to Figure 76 we have at A a branch end held in wet cotton wool, which is gripped by an ordinary (penny) American spring clothes clip.

At B is shown a small piece of sheet lead bent to form a kind of double C with a narrow groove left open at the junction of the two curves. Into this groove we may insert the stem of the specimen and turn the lead strip on edge as shown at C.

At D we have a small block of kitchen soap. In this is made a hole with a bradawl. Into the hole is inserted the petiole of a leaf. The soap is pressed up firmly round this and affords us a firm holder.

In Figure 77 we see a very useful thing for the botanist, viz.: a test tube on foot, cost one penny or twopence, according to size. At A is a light specimen held in the mouth of the tube by means of a strip of blotting paper wrapped round the stem end and plugged into the tube. As these tubes are quite light they are easily upset, therefore in all cases it is advisable to weight the base end by means of a strip of sheet lead, C, folded round the glass tube.

For a succulent stem, e.g., wild hyacinth, it is a good plan to push up from the cut end into the stem a fine steel knitting needle and then insert the free end into a block of soap, Figure 76 D.

FIGURE 78.

FIGURE 79.

Figure 78 shows us a method of utilising an ordinary retort stand and spring clip for holding a stem at a certain angle.

Figure 79 shows a very useful and yet simple plan for holding small things like buds, seeds, and so on. This holder is equally useful for the horizontal or vertical camera. An ordinary glass-headed steel pin, one to two inches long, is passed upwards through the cork of a bottle and the pin point used for holding the specimen.

When working with the vertical camera, the background paper is laid on the top of the cork and the pin passed through [illegible] [illegible] [illegible] [illegible] [illegible]

E. C. [illegible], M.A., F.L.S.

ROYAL MICROSCOPICAL SOCIETY. December 20th, H. G. Plimmer, Esq., F.R.S., President, in the chair. Mr. Rousselet described a reflecting microscope by John Cuthbert, which had been presented to the Society by the Committee of the Quekett Microscopical Club. Mr. Rousselet traced the history of the reflecting microscope from 1672, when Isaac Newton first suggested its construction to the Royal Society, down to 1827-8, when Cuthbert, at the suggestion of Dr. Goring, produced the design exhibited.

Mr. E. Shillington Scales, M.A., M.B., F.R.M.S., gave a lecture on "The Photomicrography of the Electrical Reactions of the Heart." He described the principle and construction of the Einthoven string galvanometer, with especial reference to the optical arrangements and the methods of photographing the movements of the wire resulting from the differences in potential set up by the heart-beat. He described the methods of connecting the apparatus to a hospital and the various sources of error that needed to be guarded against, and showed many actual photomicrographs of the movements of the human heart recorded by this method. Photomicrographs of the movements of the hearts of various animals under the influence of drugs were also shown.

Rev. Hilderic Friend, F.L.S., F.R.M.S., read a paper on "British Tubificidae." The author first gave a brief historical sketch, alluding to the work of Lankester, Beddard and Benham and the various Continental and other authorities, who have in past years written on the Family. After showing the difficulties attending definition, and the value of the setae for the purposes of classification, the author proceeded to arrange the British species in two classes: (1) Those genera which are destitute of capilliform setae, and (2) those which possess them. These two groups are again sub-divided, and no fewer than thirty species, besides some sub-species and varieties, are placed on record, of which ten are described for the first time, and sixteen have been added by the author during the year. Specially interesting is the discovery of a new genus, named *Rhyacodrilus*, containing two species, of which one (*R. bichaetus* Friend) is new to science. These two species are as yet known only in Derbyshire. *Ilyodrilus* is now definitely recorded as British with no fewer than five species.

A REVOLVING MICROSCOPE TRAY. As already mentioned, Messrs. W. Watson & Sons exhibited a new tray at the Public School Science Masters' Exhibition, which is useful when a number of students or others wish to look at an object placed under a microscope. The tray on which the microscope is placed (see Figure 80) [illegible] fastened to a [illegible] block which carries the lamp and travels [illegible] so [illegible] that when it is moved the lamp moves [illegible] and the [illegible] is not disturbed.

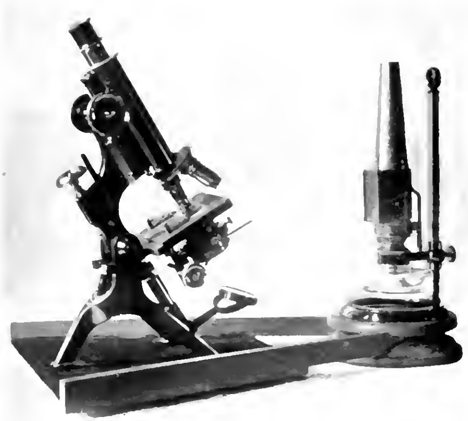


Figure 80.

A new Microscope Lamp.

NEW MICROSCOPES.—A new series of Microscopes has just been brought out by Messrs. James Swift and Son. The instruments are identical, except for the stages, which range from the simplest to the most comprehensive. The first in the series has a plain rectangular stage with spring clips, the second has a vulcanite-covered centring rotating stage, the third, which is shown in Figure 81, is of the ordinary mechanical type, now so very widely in use, the vertical movement of which is actuated by a fine rack and pinion, and the horizontal by a steel multi-thread screw. Both movements have verniers which read to one-tenth of a millimetre. The opening in the top plate is so set that it is impossible for the stage to run foul of the condenser. The next stand in the series is fitted with the firm's "I.M.S." Mechanical Stage, which gives thirty millimetres range vertically, and is so designed that the entire surface of a three inches by one inch slip can be systematically examined. This is accomplished by giving the horizontal screw movement a range of two and a-half inches and allowing of the fingers which grip the slide being moved against a vernier half an inch on either side of the normal central position. These fingers are not dependent upon a spring to hold the slide, but are pressed against it by small milled heads. By undoing a small clamp screw the horizontal movement can be entirely removed, leaving a large flat stage suitable for accommodating a Petri dish. The last instrument in the series has this same "I.M.S." stage, but it is mounted on a centring rotating base with clamps to all movements, and so is provided with every adjustment which it is possible to incorporate in a microscope stage.

The particular microscope illustrated was built at the suggestion of Professor Herbert Jackson, of King's College, London, for the use of a research chemist and analyst. For this reason it is fitted with a swing-out polariser and a Glan-Thompson prism analyser in the body, so mounted that it is capable of complete rotation.

The fine adjustment fitted to these stands is actuated by two milled heads, one on either side of the limb, that on the right carrying a divided drum, each division of which is equal to a movement of the body of ·001 millimetre. The movement of this adjustment is stopped at each end and a range of three millimetres is allowed. Special attention has been given to the design of the adjustment, so that it is an impossibility for it to [illegible] suddenly reverse [illegible] the [illegible] of its travel. The [illegible] mechanism of the fine adjustment is contained in a [illegible] milled out of the [illegible] limb of the instrument, which is so shaped that it may be conveniently lifted by the back without [illegible] to the [illegible] part.

The substage is [illegible] by means of a rack and pinion. It has complete centring adjustment, and the portion which carries the condenser [illegible] swing out of the optic [illegible].

The inclination [illegible] placed well [illegible] the stage, so that when the instrument is brought to the horizontal position, or inclined, the equal distribution of weight on either side of the centre of gravity renders it exceptionally steady and rigid.

Throughout this new series Messrs. Swift have adopted solid ground-in slides and fittings, in place of the sprung fittings which, on account of want of stability and life, they gave up some years ago.

THE PHOTO-MICROGRAPHIC SOCIETY.—It may interest those who combine the camera and microscope to know that the above recently formed society is now established on a firm basis of membership, craftsmanship and enthusiasm. At the moment of writing there are nearly fifty members, and at each meeting additions are being made. The meetings are held on the second Wednesday of each month, at 8 p.m., during the winter end of the year, i.e., October to April, both inclusive. The annual subscription is five shillings, the place of meeting the Gardenia Restaurant, Catherine Street (next door to Drury Lane Theatre, on the Strand side). At the September meeting Dr. Rodman gave an able lecture, showing that photo-micrography covered a very wide field of work; that it need not be an expensive hobby; that ordinary photographic and microscopic apparatus could readily be adapted for the

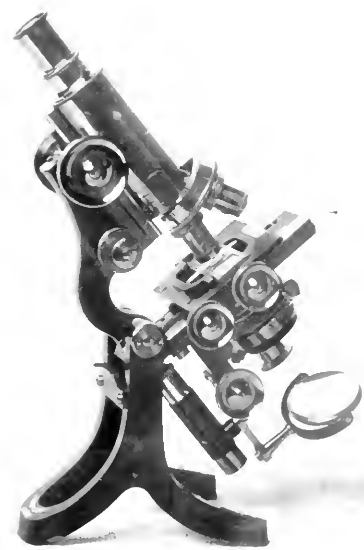


Figure 81.

A new Microscope by Swift.

work by any average handy man [illegible] cation work presented no real [illegible] care and patience could not overcome.

[illegible] by Mr. F. Martin Duncan [illegible] [illegible] work, and [illegible] the [illegible] [illegible] [illegible] made to yield [illegible] of [illegible] interest. At the third meeting Dr. J. D. [illegible] Reid [illegible] very fully into the all important matter of illuminating the object by axially transmitted light, [illegible] [illegible] [illegible] [illegible] of collecting lens, [illegible] [illegible] by diagrams and actual demonstration. [illegible] discourse has not been published [illegible] the [illegible] *The English Mechanic*, January 19th, where a reproduction of Dr. Reid's typical diagram, duly drawn to scale, may also be seen.

At the next meeting, on February 14th, Mr. A. E. Smith will deal with stereoscopic work with camera and microscope. (The precise title has not yet been announced.) Anyone interested in photo-micrography should place himself in communication with the honorary secretary, Mr. J. G. Bradbury, 1, Hogarth Hill, Finchley Road, Hendon, N.W. It may, perhaps, be of interest to state that the Society owes its origination to one of the contributors to the pages of this journal, viz., the Rev. E. C. Lambert, M.A., F.R.P.S., who has been elected the first president of the new society, which has our congratulations and good wishes.

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

BIRDS NESTING IN ENGLAND IN DECEMBER.—Mr. H. H. Wardle reports that a brood of young thrushes, fully fledged, was found near Runcorn, Cheshire, on December 20th, 1911. He remarks that December broods are not of rare occurrence and gives the following instances (collected from various sources) for the winter of 1908-9 (a mild and open season):

Dec. 1. Sparrow, young, newly-hatched, Tunbridge Wells.
" 11. Starling, four eggs, Standon.
" 12. Starling, young fledged, Cark-in Cartmel, Lancashire.
" 20. Robin, three eggs, near Mansfield.
" 22. Thrush, four young, near Devizes.
" 22. Thrush, two eggs, near Lancaster.
" 22. Starling, young about to fly, Chester-le-Street.
" 24. Starling, three young, fully fledged, near Wigton.
" 24. Robin, three eggs, Brooklands, Cheshire.
" 29. Starling, young, half-fledged, Stockbridge.
" 29. Starling, three eggs, Stainmore Fells.
Jan. 3. Robin, three eggs, Overton, Hants.
" 5. Thrush, four eggs, Quarry Bank, Market Drayton.
Jan. third week in). Moorhen, young birds, Botley, Hants.

(*The Field*, December 30th, 1911, page 1447.)

The frequency of the occurrence of the Starling in the above list is further evidence of its adaptability and vigour in pushing to the front.

PENGUINS BREEDING.—The nesting of introduced species kept in confinement is, of course, a different thing; but it is interesting to know that a pair of black-footed or Jackass Penguins (*Spheniscus demersus*) hatched out two young in the Zoological Gardens, London, in November last. These birds are winter breeders in a wild state, nesting on islands off the Cape in May and June, with which months our winter, of course, corresponds. When they nest in the "Zoo" in our spring or summer months their eggs are rarely fertile, but they generally succeed in hatching and rearing their young when they nest in autumn or winter, as in the case under notice. Birds from the Southern Hemisphere, unless conforming to our seasons here, fail generally in their nesting efforts. (D. Seth-Smith, *The Field*, November 25th, 1911, page 1176.)

FURTHER NEW BRITISH BIRDS.—This month one new species and a sub-species are chronicled, and also another species which has been hitherto included in the British list [illegible] from the [illegible] and not accepted [illegible] [illegible]. The new records are:—

PINE BUNTING (*Emberiza leucocephala*) AT FAIR ISLE.—Mr. Wm. Eagle Clarke received a male bird in full winter plumage, taken at Fair Isle, on October 30th last, amongst a rush of winter migrants. It is a native of Siberia, wintering in North China, Mongolia, Turkestan and the Himalayas, and is only a straggler in Europe, never having been known to visit the British Isles before. (*The Scottish Naturalist*, January, 1912, page 8.)

THRUSH NIGHTINGALE (*Luscinia luscinia*) AT FAIR ISLE.—This "waif" (of whose occurrence in Britain there is only the one record referred to above, which was at Smeeth, Kent, on October 22nd, 1904), turned up at Fair Isle during the spring migration of 1911, "in company with a crowd of birds of passage," and was secured on May 15th. The species is sometimes called the "Sprosser," and its summer range is from Denmark to south-western Siberia, its winter quarters being in Eastern Africa (*Loc. cit.*, page 9.)

NORTH AMERICAN PEREGRINE IN ENGLAND.—The American form of the Peregrine Falcon (*Falco peregrinus anatum*) has recently been identified as occurring in England, and some particulars, with a photograph, are given in *British Birds* for January, 1912 (V, pages 219-21). One bird was netted on September 28th, 1910, in plover nets at Humberstone, Lincolnshire. Another bird, shot nineteen years earlier near Market Bosworth, Leicestershire, on October 31st, 1891, was shown at a meeting of the British Ornithologists' Club on June 14th, 1911. Both are considered to be young specimens of the above named form, and are new records, not only for the British Isles but for Europe. Its breeding quarters are from the sub-arctic regions of Canada and western-central Greenland, southwards to some of the United States; wintering from southern British Columbia, Colorado and New Jersey to the West Indies and Panama, and occurring in southern South America. Its great powers of flight are considered to account for its appearance in England, and we suppose that the reporters of the above are satisfied that the birds were not "escapes" from confinement.

THE SCOTTISH NATURALIST.—This is an old title revived in place of the somewhat ponderously named *Annals of Scottish Natural History*, the last-named being now dropped and incorporated in a new monthly called *The Scottish Naturalist* (Edinburgh: Oliver & Boyd. London: Gurney and Jackson. Annual Subscription, 6/6). It is devoted to Zoölogy alone, and ornithologists will particularly value it as a medium for reporting the work and bird studies so enthusiastically pursued in the North.

BIRDS NEW TO SCOTLAND.—The first number contains an account of the recent occurrences of as many as five different species for the first time in Scotland, *viz.*, the Pine Bunting and Thrush Nightingale (both new to Britain, see above), and Baird's Sandpiper (*Tringa bairdii*), Woodchat Shrike (*Lanius pomeranus*) and Serin Finch (*Serinus serinus*). There are also a number of bird notes from well-known observers.

ZOOLOGICAL LITERATURE.—Going further afield than Scotland, a new feature promised is a section devoted to short notices of recent literature in all branches of British Zoology. This department is much neglected at present by our natural history magazines, and, if well done, would be most useful. It is to be hoped that a serious effort may be made to attain complete records. If the section could take the form of a subject index to current British zoological literature, it would indeed be a boon to readers and students. May it be so.

BIRD FLIGHT THEORIES.—In a series of articles in *Flight*, Mr. E. H. Hankin, M.A., D.Sc., has recently been giving the result of his extended and minute observations of the flight of large birds (vultures, and so on), in India. Apart from the scientific value of his keen and carefully recorded observations of all varieties of bird-flight, the conclusion to which he came regarding the mystery of soaring flight has attracted much attention. By his investigations he disproved (or at least showed good reason for disbelieving) every theory hitherto advanced to explain the soaring flight of birds. He found also that the birds cannot [illegible] if the sky is densely overcast; either direct sunshine or at least good sunlight are necessary. His conclusion is that the sunlight stores up in the air some form of potential energy which by the passage of the bird's wings becomes liberated as kinetic energy and gives the sustaining power. Minute explosions or molecular bombardment are terms which express the idea of the liberation of the energy. To this supposed allotropic form of the atmosphere Dr. Hankin gives the name of "ergaer." People who have not followed his record of observations and careful scientific reasoning may be inclined to smile, but he makes a good case, and points to lines of original research which his idea — really a working theory — opens out. Mr. Hankin lectures to the Aeronautical Society of Great Britain on January 22nd, and he may then possibly say something more on [illegible] theory.

PHOTOGRAPHY.

By EDGAR SENIOR.

FURTHER NOTES ON PRINTING WITH IRON SALTS.—In "Notes" of last issue the method of iron printing described gives white lines on a blue ground, "unless a negative be employed," in other words, the prints themselves are negative ones. This is not always desirable. As to whether the prints produced are negative or positive depends upon whether the agent used to develop the blue compound reacts with the altered or unaltered salt. In the case already considered, the blue compound results from the reaction of the potassium ferricyanide (red prussiate of potash), with the ferrous salt produced by the action of light. If, however, potassium ferrocyanide (yellow prussiate of potash) be used instead, the blue compound results from its action upon the unaltered (ferric) salt forming the compound known as Prussian blue $Fe_4(FeCy_6)_3$. Advantage is taken of this for obtaining positives from positives direct. In order to carry this out in practice the following solutions are made, and the mixture applied to well-sized paper in a subdued light:

1.

Ferric chloride … … …	34 grains.
Tartaric acid … … … …	17 „
Sodium chloride … … …	15 „
Water … … … … …	2 oz.

2.

Gum-arabic … … … …	107 grains.
Water … … … … …	1 oz.

The [illegible] mixed and then applied to the paper by means of a brush in as even a manner as possible, and dried quickly in a [illegible] in order that they shall not sink into the paper. The printing may be done in sunlight in a few minutes, or in diffused daylight for a correspondingly longer time, but a little experience soon enables one to judge by appearance when the printing has been carried far enough. To develop the print a strong solution of potassium ferrocyanide is used, floating the exposed surface upon the solution, care being taken not to wet the back. When fully developed, float on clean water for a few minutes and then immerse in a ten per cent. solution of hydrochloric acid for a short time and then thoroughly wash. If the ground is stained blue the print has been under exposed probably, and with care the white portions should be quite free from any blue colouration, the acid being used in order to insure this. With over exposure, however, it frequently happens that the ground is stained a light blue tint, due to the potassium ferrocyanide giving with ferrous salts a bluish-white precipitate of potassium ferrous ferrocyanide of the following composition ($K_2Fe''FeCy_6$). In some instances, it has been found advantageous to print through the paper, in which case the object being copied must be placed in its proper aspect with regard to left and right, otherwise the print will be reversed.

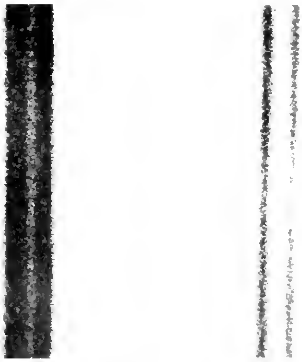


FIGURE 82.

FIGURE 83.

SPREADING OF THE IMAGE OF FINE LINES.—Anyone who has done much work in the photographing of fine lines, or structures of that kind, must have noticed the general thickening - up which takes place, rendering the image coarser and unlike the original in appearance. This is well shown in the accompanying illustrations, which are photo - micrographs enlarged sixty diameters. In Figure 82 *a* we have the enlarged image of two fine lines separated by a distance of [illegible] millimetre ([illegible] in.), and in Figure 82 *b* an image of the same two lines from a negative that had received [illegible] the exposure of *a*. It will be seen that not only has the space between almost entirely disappeared by the prolonged exposure, but that the spreading has extended to the outer edges as well, to such an extent that the total increase in the width of *b* as compared with *a* is nearly three [illegible] in the enlarged image.

In two other photographs on the same plate, [illegible] exposures had been further increased [illegible] the separation between the lines had [illegible] and still further spreading occurred, [illegible] lines had become one thick one. It may [illegible] this case exceptional, since lines separated by ... m. cannot be resolved by the unaided eye, but the tendency to close up is always present, and selecting something with very small distances apart tends to show more clearly the phenomenon. It is also found that the spreading varies with different plates, in one instance the variation between a collodion plate and the same image taken on a gelatine one, amounted to a difference of ... millimetre in favour of the collodion even although this had been intensified. In Figure 85 is shown the result of doubling the exposure in taking the photo-micrograph, from which it will be seen that the lines are tending to become thinner, due to the extra length of exposure given in the taking of the photo-micrographs. These examples should be of interest as illustrating the great care necessary in photographing subjects of this nature.

PRINTING WITH SALTS OF CHROMIUM. The following printing process, due to the investigation of Robert Hunt, and announced by him in 1843, under the name of "Chromatype," deserves attention owing to its simplicity together with the good results obtainable by its means. Well-sized paper is washed over with a solution of copper sulphate, and when dry coated with a fairly strong solution of potassium bichromate. The paper when dry may be kept for a short time ready for use. In order to employ this paper, it is placed with the object or objects upon it, in a printing frame and the whole exposed to light for a sufficient length of time to render the paper almost white, when a yellow positive on a white ground results. On removal from the printing frame the paper is floated upon a solution of silver nitrate when the parts that have been unacted upon by light at once assume a dark purple-red colour from the formation of silver bichromate. To fix the images the prints are well washed in distilled water free from chlorides, as these latter have a destructive action, even when present in small quantity. Prints produced by this method appear to be stable, not undergoing any change when exposed to strong light for a considerable time.

EXPOSURE TABLE FOR FEBRUARY. The calculations are made on the actinograph for plates of speed 200 H. and D., the subject a near one and lens aperture F/16.

Day of the Month	Condition of the Light	Time of Day: 11 a.m. to 1 p.m.	10 and 2	3 p.m.	Remarks
Feb. 1st	Bright	25 sec.	3 sec.	6 sec.	
	Dull	5	6 ,,	12	If the subject be a general open landscape take half the exposures given here.
Feb. 15th	Bright	2 sec.	25 sec.	4 sec.	
	Dull	4 ,,	5 ,,	8	
Feb. 29th	Bright	15 sec.	2 sec.	3 sec.	
,,	Dull	3 ,,	4	6 ,,	

PRINTING WITH COBALT OXALATE. This process, originally devised by Messrs. Lumière, is capable of giving very fine results. Unfortunately, perhaps, a certain amount of skill in chemical manipulation is necessary to carry it out successfully. It is based upon the action of light in reducing cobaltic oxalate to cobaltous, and this on suitable treatment is made to yield an image finally in sulphide of cobalt. In our first experiments cobaltous hydrate was suspended in water, through which a current of chlorine was passed, until a black precipitate of cobaltic hydrate was formed, and to ensure the action being complete caustic soda was also present in the water as well. The black precipitate was then carefully washed and dissolved in a calculated quantity of oxalic acid, it being of importance not to have an excess of acid. The formation of the oxalate should be gradual, and the operation allowed to go on in darkness. The dark green solution of cobaltic oxalate was then employed to sensitize gelatine-coated paper, which must be used as soon as dry. The printing under a negative is fairly rapid, the colour of the paper changing over the parts exposed to light to a pale rose tint, due to the formation of cobaltous oxalate. The prints on removal from the printing frame are treated with a 5% solution of potassium ferricyanide, which deepens their colour; they are then washed in running water for about thirty minutes, after which they are placed in a dilute solution of ammonium sulphide for times varying with the colour desired. A short immersion gives a sepia, a prolonged one black. A final washing completes the operations. A simplified method of preparation of the oxalate consists in treating cobalt sulphate with soda peroxide (Na_2O_2), adding the latter gradually and keeping the solution well cooled to prevent decomposition. The precipitate is then well washed to free it from soda sulphate, and dissolved in a calculated quantity of oxalic acid as before.

PHYSICS.

By Alfred C. G. Egerton, B.Sc.

SILICA. Fused silica is now used largely in place of glass and porcelain for vessels which have to stand heat without risk of cracking. It possesses an exceedingly small coefficient of expansion. Consequently, when suddenly heated the mechanical forces set up in the material owing to the expansion are not great enough to cause cracking, as in the case of similar bad-conducting substances with large coefficient of expansion—such as glass or porcelain. It is eminently suitable as the material for a primary standard of length. It is cheaper than platinum or iridio-platinum, and is not so greatly affected by change of temperature as silica. It has a coefficient of expansion seventeen times less than that of platinum. Invar, the nickel iron alloy, which possesses a smaller coefficient of expansion than any other metal, is not so suitable a material as silica for a standard of length. Dr. G. Kaye has prepared a standard metre from silica. It consists of a tube of silica with slabs of the same material fused into its ends. The slabs are optically worked planes, and platinised on the underside; the platinum film is then ruled with a diamond so as to give the defining lines between which the standard length is measured.

It will be remembered that the standard metre is the distance between two marks on a bar of platinum which is preserved at the International Bureau of Metric Standards, Saint Cloud, near Paris. It was originally made to be as nearly as possible equal to one ten-millionth of a quadrant of the earth from equator to pole. However, it is now known that the length of the standard metre is not exactly the ten-millionth of the earth's quadrant, but this latter is equal to 10,001,472 metres.

Although the standard metre, and, in fact, any such arbitrary standard that is based on the length of a certain piece of metal, might alter in the course of ages owing to certain cosmic changes, yet they can always be checked against the lengths of certain waves of light. Different elements give out light of different wave-lengths; each element has its own characteristic spectrum. One can choose some special element and then choose some special wave-length of light, given out by that metal and find how many such wave-lengths make the standard metre; thus the standard of length can be expressed in terms of the wave-length of a certain line in the spectrum of a certain metal. This has been done by Professor Michelson, for the red line given by the metal cadmium.

The manufacturers of vessels of fused silica have so perfected their processes that the most complicated apparatus can now be obtained, and it is an economy to buy apparatus which is to be subjected to sudden changes of temperature made of silica rather than glass or porcelain. Silica is not attacked by acids, with the exception of hydrofluoric acid. It melts at about 1,600° C. It is harder than ordinary glass. Above 1,000° it is permeable to hydrogen. It is also readily permeable to helium, and recently Professor O. W. Richardson has shown that neon can penetrate through the walls of a tube made of silica, though less easily than helium. It expands regularly up to nearly 1,000° C., and is exceedingly well suited for making high temperature mercury thermometers, which register temperatures up to 700° C., the mercury being under pressure. Owing to its small coefficient of expansion, silica is a convenient material of which to make a specific gravity bottle, or pyknometer. A pyknometer is a small tube drawn out to a tube of fine bore at each end; one of these fine tubes is bent round so as to form a U tube, with the tube of larger bore as one of the limbs of the U. The apparatus is weighed, full of water up to a certain mark on the small tubes, and also full of a liquid of which it is required to find the density. From the two weighings a measure of the density of the liquid is obtained, provided proper precautions are taken for observing the temperature. When using a glass pyknometer it is often necessary to take account of the expansion of the glass itself, but with a silica pyknometer this is not necessary; while the latter are much easier to clean and dry, because they can be heated strongly without fear of cracking.

Silica is an excellent insulating material for electrical instruments. Glass adsorbes water on its surface; this water dissolves the silicates of the glass, and forms a conducting layer on the surface of the glass; unless very dry glass is a poor conductor, but silica has not got this defect.

Professor Strutt some years ago constructed a tube of silica in which to measure the electrical conductivity of mercury at high temperatures. The quartz tube was the shape of an inverted Y. The tube was nearly completely filled with mercury. Wires led into the two limbs of the Y tube, and were sealed in with wax. The junction of the limbs of the Y was strongly heated. At a red heat the resistance of the mercury was about doubled. Mercury boils under atmospheric pressure at 356·7 C. By heating it in a closed quartz tube of the above description it was possible to keep it in the liquid form well above this temperature, and thus obtain red hot mercury. It was not possible, without bursting the tube, to reach the critical point, at which temperature the mercury would go over from the liquid to the gaseous condition, and above which it would not be possible to obtain liquid mercury. It appears, though, from the experiments that the electrical resistance of liquid mercury would be the same as that of the mercury vapour at the critical point.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

IS LEFT HANDEDNESS HEREDITARY? This question has been recently studied by Professor H. E. Jordan. The cause of left-handedness remains obscure, though it may be regarded as a congenital asymmetry such as is common in organisms. There is much to be said for Sir D. Wilson's conclusion that left-handedness is associated with a greater development (preponderant size and weight) of the right cerebral hemisphere. As we have previously remarked in these Notes, the percentage occurrence in various races is not known with any accuracy. The anatomist Hyrtl puts it at two per cent. among the civilised races of Europe, which is not far off what it was long ago among the warriors of the tribe of Benjamin. It is important to distinguish between structural asymmetry (difference in size and weight), and functional inequality (difference in deftness). It is not less important to try to distinguish between a constitutional tendency and the result of education. Thus most parrots receive with the left foot, but that is because they are ordinarily approached in feeding with the right hand. When the left hand is consistently employed in the feeding, the parrot responds with its right foot. Jordan has investigated seventy-eight lineages in which left-handedness was noted in a survey of about three thousand individuals, and his facts go to show that left-handedness is hereditary. But they do not throw any light on the mode of the inheritance. Left-handedness does not even appear to follow Mendelian principles of inheritance, but the data are somewhat limited. So far as they go they merely yield the conclusion that left-handedness is in some way hereditary.

INTER-SPECIFIC AND INTRA-SPECIFIC STRUGGLE FOR EXISTENCE. In a report on a recent visit to Cavilli Island, one of the Philippines, Mr. Dean C. Worcester has the following vivid passage which well illustrates the struggle for existence between antagonistic species, and at [illegible] the struggle [illegible] between members of [illegible] the red-legged boobies [illegible] and the frigate birds (*Fregata aquila*). "Just before dark, as we were leaving, [illegible] we witnessed an extraordinary scene. Large numbers of red-legged boobies which had apparently been fishing [illegible] began to return, bringing fish to their nestlings [illegible] their young. The frigate birds promptly formed a [illegible] line and, singly or in pairs, attacked all comers [illegible] them to give up their fish. Some of the boobies [illegible] sophisticated individuals which had learned wisdom [illegible] experience, actually handed their fish over to the frigate birds and so escaped without much drubbing, but less [illegible] or more obstinate individuals, which at first refused [illegible] were vigorously punished until they changed their minds and threw up their fish which were most adroitly [illegible] the air by their piratical enemies. In one instance, two frigate birds set upon a booby, one of them attacking him from above, and the other flying below to catch the fish which he dropped, and getting five out of seven. Soon the incoming boobies began to arrive in flocks, and the frigate birds were not able to set upon them all, so that many individuals got through to the island. Once among the trees they were left in peace."

WARNING COLOUR IN A CHAMELEON. Cyril Crossland records the fact that a chameleon can frighten a dog by its rapid change of colour. It was a fox terrier's attack that he watched. The chameleon tried to run away, but it is not good at that! "In a few seconds the impossibility of escape seemed to reach the animal's brain, when it at once turned round and opened its great pink mouth in the face of the advancing foe, at the same time rapidly changing colour, becoming almost black. This ruse succeeded every time, the dog turning off at once. In natural leafy conditions the startling effect would be much greater, a sudden throwing off of the mantle of invisibility and the exposure of a conspicuous black body with a large red mouth.

LIFE OF TISSUES REMOVED FROM THE BODY. Everyone knows that a piece of a branch or a piece of a potato-tuber will remain alive for a considerable time after it is cut off, that posts of wood driven into the ground sometimes burst into leaf, that a small fragment of many a plant, from liverwort to begonia, may grow into an entire plant. Similarly, among animals, the excised heart of a turtle, in appropriate conditions, will continue beating for several days after the bulk of the animal has been made into soup, and has passed into a new incarnation. A fragment of sponge, of hydroid, of sea-anemone, of certain worms, and so forth, can regrow the whole. We should like to have more information in regard to the limits of these experiments. In the case of Hydra it has been found that the regenerating fragment must not be very small (a quantitative limit) and that it must contain samples of the different kinds of cells in the body (a qualitative limit). Professor H. V. Wilson has recently shown in regard to some sponges that they may be minced and strained through a cloth strainer,—and yet the debris poured out in an appropriate place will develop into a proper sponge. Of late, too, interesting experiments have been made in keeping pieces of tissue alive in suitable media outside the body. What happens in most cases is that they flourish for a time (three to fifteen days) and then cease growing and die. It has been suggested, however, that the death may be rather contingent than necessary. It may be due to the accumulation of waste products. So Alexis Carrel has devised a system of artificial rejuvenescence, washing the tissue from time to time with "Ringer's solution," and placing it in a medium of [illegible] and distilled water. A piece of connective tissue [illegible] times, staving off senescence and death, and [illegible] actively thirty-four days after its removal [illegible].

FOSSIL WASPS' NESTS. The [illegible] imperfections are so often proclaimed [illegible]. We have just been reading a description [illegible] Anton Handlirsch of some hazel nut [illegible] Oligocene of Florsheim. They occur [illegible]

[illegible] ed [illegible] tences. [illegible] *Eunice pomiformis* [illegible] all of the [illegible] ts are made [illegible] sand, and the [illegible]

[illegible] SEA WATER. It has been [illegible] [illegible] natural antipathy to salt [illegible] which Mr. A. S. Pearse made [illegible] show that there are exception[illegible] He quotes Dr. Gadow's words, "Com[illegible] Amphibia; even a solution of 1 per [illegible] development of their larvae," and then [illegible] frogs of the genus *Rana* hopping [illegible] flats in [illegible] *estero* or tidal creek opening into Manila Bay. Two [illegible] made by the crab *Sesarma bidens* [illegible] to be [illegible] wriggling tadpoles newly hatched. [illegible] of water from a pool with tadpoles on the edge of the [illegible] analysed, and it was found that the tadpoles were [illegible] diluted sea water, containing as high as 2·006 per cent. of sodium chloride. It seems, then, that both tadpoles and frogs can stand much more than a grain of salt.

HOW DO ANTS FIND THEIR WAY HOME?—F. Santschi has made experiments bearing on this old problem. In the case of some storing ants the pathway is "intentionally" marked by an odoriferous secretion from the worker. This "scent" is followed by others, but it may be supplemented by tactile data. In the case of hunting species, sight may be of importance. It is probable that the eyes make some use of ultra-violet rays. The observer's general conclusion is that the sense of direction in ants is a complex phenomenon, [illegible] external stimuli appeal [illegible] touch, muscular sense, [illegible] The [illegible] number in some cases than [illegible] the trail is formed by a literal "scent."

INTERESTING ADAPTATION IN A BURROWING CRUSTACEAN.—A. S. Pearse describes the habits of *Thalassina anomala*, an interesting Crustacean which is, in some respects, like a link between the long-tailed Macrura and the hermit crabs. It is a common burrower on the edges of the Philippine estuaries and makes holes not only in the softer ground but in the hard clay of the grassy meadows. In the latter the holes go down till they are below the water-level. The animal seems to be able to live in poorly aerated water, as Bate surmised long ago from his study of preserved specimens. "Its habits," Pearse says, "are such that this ability would often be of advantage. It possesses an adaptation that is probably for this purpose, that is, the branchiostegites (or gill-covers) are moveable on the dorsal portion of the carapace by a sort of flexible hinge joint. An individual placed in a dish will often move the sides of the carapace in such a manner that it resembles a vertebrate gasping for breath. Such movements would serve to clear the water quickly from the branchial chamber."

LIFE ON THE PLANETS.—Life requires atmosphere, and according to Professor Svante Arrhenius the only planets in our system that have an atmosphere as we have are Mars and Venus. But what a difference between the two! For whereas Venus is beginning to be fit to be a home of life, recalling what the Earth was like very long ago, Mars has almost quite lost what it once had. This, at least, is the view taken by Arrhenius in his recent essay on "The Fate of the Planets."

NOTICES.

AGRICULTURAL EDUCATION.—We are informed by the Presidents of the Boards of Agriculture and Education that the responsibility for Farm Institutes, as well as for the agricultural work of the Universities and Colleges, will be transferred to the Board of Agriculture, and that this Board will be regarded as the Government Department concerned with this branch of Educational Work for the purposes of the Development Fund.

A NATURE CALENDAR.—A calendar for hanging on the wall, issued by Messrs. George Philip & Sons, contains some interesting suggestions on each of the pages devoted to the months with regard to what can be done in the garden and what is going on in the plant and animal world, so that Nature lovers may find more by looking at it than the mere days of the week and their dates. The price is 6d. net.

GOLD MEDAL OF THE RHODESIA SCIENTIFIC ASSOCIATION.—The Rhodesia Scientific Association's gold medal, recently offered for an original paper advancing the knowledge of the transmission of any insect or arachnid borne disease affecting Rhodesia, has been awarded to Edward Hindle, Ph.D., A.R.C.S., F.L.S., Magdalene College, Cambridge, Beit Memorial Research Fellow, for his paper on "The Transmission of *Spirochaeta Duttoni*."

A NEW CHEMICAL MAGAZINE.—We extend a cordial welcome to the new monthly journal which Messrs. J. and A. Churchill have published under the title of *The Chemical World*. Its [illegible] to [illegible] to those interested in the many branches of Chemistry an account of progress in both theory and practice, discussing such other matters as may be expected to influence the future progress of this science. *The Chemical World* is edited by Mr. W. P. Dreaper, F.C.S., F.I.C.

THE USE OF THE MICROSCOPE.—Two demonstrations on the use of the microscope and its accessories will be given at the South-Western Polytechnic Institute, on February 12th and 19th, by Mr. L. Sumner, from six to seven o'clock in the evening. The matters touched upon will include, among many others, illumination of opaque objects; the determination of the focal length of objectives; the influence of tube lengths and thickness of cover glass on definition; and drawing with the camera lucida.

HOME MUSIC STUDY UNION.—This union has, for several years, arranged annual courses of study to suit various classes of music lovers, and it has also published special articles in *The Music Student*, as well as text books which give information that could not otherwise be readily obtained. Music circles exist in many towns, and there are now forty centres connected with the Union. All information with regard to it can be obtained from the Secretary, 12, York Buildings, Adelphi, London.

PORT ERIN BIOLOGICAL STATION.—The twenty-fifth annual report of the Liverpool Marine Biology Committee has reached us, and as usual contains records of much valuable work on the part of the staff and students. Sixty of the latter occupied the work tables during the year, and a description of the researches carried out is given. The report also includes a list of subscribers, which though a good one, ought to be very considerably extended. The Honorary Director, Professor Herdman, F.R.S., is to be congratulated on the progress of his work.

NOTICE OF REMOVAL.—The Electro-medical business of Messrs. Newton and Company has increased so greatly that it has been decided to form a private limited liability company under the name of Newton and Wright, Limited, which will carry it on at 72, Wigmore Street, W. Mr. H. C. Newton, the senior partner of Messrs. Newton and Company, will become Chairman of the new company, and Mr. R. S. Wright, the junior partner, will be Managing Director. The whole of the shares will be held by the present partners, together with some senior members of the staff, and the *personnel* of the department will remain entirely unchanged.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MARCH, 1912.

SOME NOTES ON THE CHEMISTRY OF INDIA RUBBER.

By H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S.

I. Natural Rubber.

INDIA-RUBBER is obtained from a number of trees of which the most important is the para rubber tree, *Hevea Braziliensis.* This tree yields the finest of all rubber, and, as its name implies, is indigenous to Brazil. In recent years, however, numerous experiments have been made to cultivate para rubber trees in other parts of the world, many of which have proved very successful. *Hevea Braziliensis* requires for its cultivation a moist, warm climate; it has been found to thrive particularly well in the Malay Peninsula, as well as in Ceylon. It can also be grown successfully in Guiana and certain parts of Africa; but the greater portion of Africa, as well as Mexico and the West Indies has been found unsuitable for its growth. The output of plantation rubber, however, is as yet small compared with that of wild rubber. Figure 84* is an illustration of a rubber plantation in Malaya. Figure 85 shows the flower of the para rubber tree.

FIGURE 84.
A Rubber Plantation in Malaya.

In Brazil, wild rubber trees are generally tapped by a single incision in the bark. Plantation trees are usually tapped by cutting the bark in one of the three manners shown in Figure 86, though other methods of tapping have also been tried. Each day, or less frequently, a thin shaving of the bark adjacent to each of the cuts is pared away. The milk, or rubber latex, which exudes from the cuts, runs down the central channel, and is collected in a vessel placed to receive it. The rubber has then to be separated from the latex. In the case of Brazilian wild rubber, this is effected by subjecting the latex to the smoke produced by burning certain nuts, and so on; but in the case of plantation rubber the latex is generally coagulated by the addition of dilute acetic acid. Plantation rubber is also washed and rolled in special machines, and then dried (an operation effected in Malaya by smoking the rubber), before exportation; wild rubber has to be treated in this manner after exportation.

* Our heartiest thanks are due to the Malay States Development Agency for photographs reproduced in Figures 84, 85, 87 and 88.

and several manufacturers also re-wash and dry plantation rubber, though this repetition of the process is not really necessary. After washing and drying, the rubber is compounded with various mineral matters, and vulcanised by combining with it a small quantity of sulphur. This vulcanising process renders it tougher and chemically more inert. Vulcanite itself is manufactured by combining rubber with a much larger quantity of sulphur.

The washing process frees the rubber from all mechanical impurities, such as pieces of wood, vegetable fibres, and so on, and also any soluble impurities. The product obtained is described as technically pure, but it is not chemically pure. Besides pure rubber, or caoutchouc, it contains various resinous, albuminous and mineral matters, as well as small quantities of an oxygen compound discovered by Dr. Weber,[1] possessing the empirical formula $C_{15}H_{31}O_{2}$. In para rubber, the amount of resin varies from one to four per cent.; but in certain low grade rubbers it may reach as much as forty per cent. The resinous matter is removed, for purposes of analysis, by extraction with acetone. The separation of the proteids or albuminous matters is best performed by centrifuging. The percentage of mineral ash left after combustion is generally very small.

Pure rubber, or caoutchouc, is a hydrocarbon with the empirical formula C_5H_8. Its molecular weight is not known, but that it is very high may be safely concluded from the properties of the substance. Its true formula, therefore, is some unknown multiple of C_5H_8; in consequence, it is written $(C_5H_8)n$.[2] Its colloidal nature renders it a difficult body to study, since like other colloids it possesses no definite melting point or solubility; moreover, it is not a chemically active body.

FIGURE 85.
The Flower of the Para Rubber Tree.

In the sense that sugar is soluble in water, caoutchouc is not soluble in any liquid. When, however, certain fluids (e.g., petroleum spirit, benzene, carbon disulphide, and so on) are poured on to rubber, it swells very much, forming first a jelly, and ultimately a very viscous fluid. That the product is not a true solution *of* rubber, but rather a solution of the so-called solvent *in* rubber, is evident from the fact that on the further addition of the "solvent" to the fluid jelly, the latter tends to separate out. Certain other fluids, such as water, alcohol, and so on, which do not form fluid jellies of this sort with rubber, are gradually absorbed by it, water to the extent of twenty-five per cent., alcohol to that of twenty per cent., the rubber becoming much distended in the process.

On the dry distillation of rubber, various hydrocarbons, all possessing the empirical formula C_5H_8, and belonging to the group of substances known as "terpenes," are obtained. These include Isoprene (Methyl divinyl), C_5H_8; Dipentene (at one time known as caoutchene), $C_{10}H_{16}$; Heveene; and certain polyterpenes. Dr. Weber gives the following table, showing the result of distilling three kilogrammes of carefully washed and vacuum-dried para rubber.

			per cent.
Isoprene	... 186	grms.	6·2
Dipentene	... 1380	,,	46·0
Heveene	... 510	,,	17·0
Polyterpenes ...	806	,,	26·8
Carbon residue	59	,,	1·9
Mineral residue	16	,,	0·5
Loss (water and gases)	... 43	,,	1·4

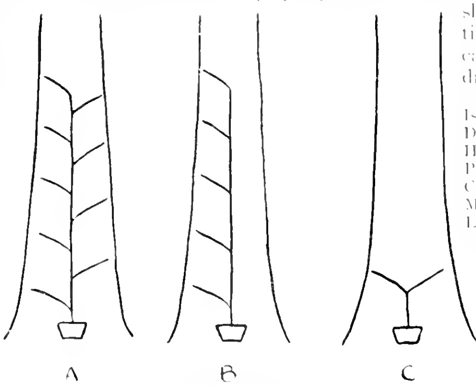


FIGURE 86.
Methods of Tapping.
A. Whole Herring-bone. B. Half Herring-bone. B. Basal V.

Of these products isoprene is the most interesting, because it polymerises spontaneously, partly into dipentene and partly into caoutchouc. Isoprene is a colourless liquid, boiling at 37° under normal atmospheric pressure. It has the constitutional formula:

$$\begin{array}{l} CH_2 \\ C \cdot CH : CH_2 \\ CH_3 \end{array}$$

[1] *Journal of the Society of Chemical Industry*, 1900. See also Carl Otto Weber, Ph.D., "The Chemistry of India Rubber" (1902), pages 7–11.

[2] Gladstone and Hibbert (*Journal of the Chemical Society*, 1888) concluded from an examination of the refractive index of rubber solution that caoutchouc contains three ethylene bonds, and that, therefore, the simplest formula possible for it is C[illegible]H[illegible]. Their evidence, however, is not conclusive, owing to the method of calculating molecular refractivities employed.

Its polymerisation into dipentene (a hydrocarbon present in Russian and

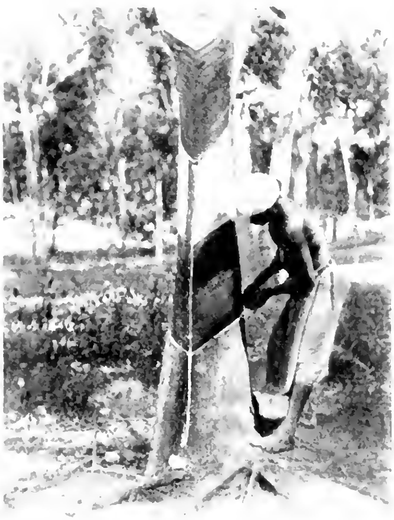


FIGURE 87.

A Rubber Tree, Government Plantation, Kuala Lumpur.

Swedish turpentine) is shown by the following equation —

CH₃ C—CH CH₂+CH₂ C CH
CH₂ CH₂ CH

2 molecules Isoprene.

CH C—CH CH₂ CH₂ C CH
CH₂ CH₂—CH

1 molecule Dipentene.

and it is presumably by some similar, though more complicated, reaction (that is, involving more molecules of isoprene) that it is changed into rubber.

II. SYNTHETIC RUBBER.

Some of the greatest achievements of chemical science in recent times have been in the direction of the synthesis from inorganic materials of various important products of the vegetable and animal world. Since the day in 1828 when Wöhler performed the first synthesis of this nature — the preparation of urea from ammonium cyanate — an immense number of animal and vegetable products have been artificially prepared in the chemical laboratory, amongst which caoutchouc must now be included.

Synthetic rubber must not be confused with the various rubber substitutes and imitations of rubber which have from time to time been placed upon the market. Such rubber substitutes and imitations are bodies with merely a superficial resemblance to rubber, whereas by "synthetic rubber" is meant a body chemically and physically identical with the natural product, though prepared by artificial means. The most important rubber substitutes are obtained by boiling linseed or other oils with sulphur, or acting on them with disulphur dichloride, when chemical combination takes place. They are used commercially for mixing with certain low grade rubbers.

The synthesis of rubber divides itself into two processes, (i) the production of isoprene, (ii) the polymerisation of isoprene to caoutchouc.

As we have already noted, the second of these processes takes place spontaneously, but it may be facilitated by means of concentrated hydrochloric acid, or by saturation of the isoprene with oxygen or ozone. The latter process is as follows* :—The isoprene is saturated with oxygen or ozone, allowing twenty volumes of oxygen to one volume of the hydrocarbon, and spreading the treatment over about six hours. The liquid must be kept cool during the process. It is then placed in an autoclave and heated to 100°C, until it is converted into a viscous mass. The resulting caoutchouc is dried by evaporation, or precipitated by means of alcohol. A solution of isoprene in benzene may be used instead of the pure substance. The heating is not absolutely necessary, though advisable.

Another method is to act on the isoprene with one of the alkali metals, (*e.g.*, sodium or potassium) or an alloy of one of these metals.†

To turn to the preparation of isoprene. The following method‡ is interesting scientifically, because it is a true synthesis of isoprene, in which it is built up from simpler

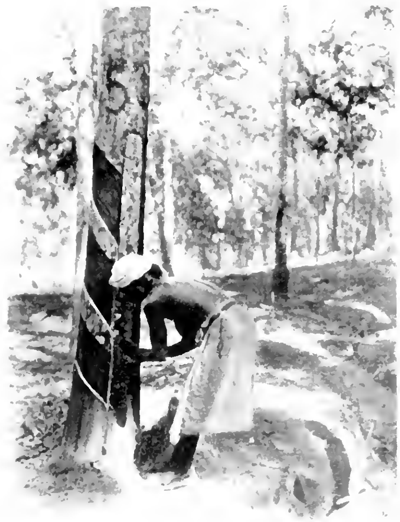


FIGURE 88.

Tapping Rubber Trees, Government Plantation, Kuala Lumpur.

* English Patent, 1910, No. 14,041. A. Heinemann. *Improvements relating to the Polymerisation of Isoprene.*

† English Patent, 1910, No. 24,790. F. L. Matthews and E. H. Strange. *Synthetic Caoutchouc.*

‡ English Patent, 1907, No. 21,772. A. Heinemann. *A Process for the Synthetic Production of India-rubber.*

[illegible] and [illegible] ethylene are combined to form [illegible] them together in a tube [illegible] and the resulting divinyl [illegible] the methyl derivative isoprene [illegible] chloride, thus:

[illegible] CH [illegible] CH . CH.CH : CH
[illegible] Divinyl.

The apparatus is shown and described in Figure 89. Mr. Heinemann, whose patents we have already referred to, finds that the yield of isoprene may also be very considerably improved by passing the turpentine vapour over finely-divided copper or silver, or, better, by using tubes made of either of these metals. The temperature must be kept low,

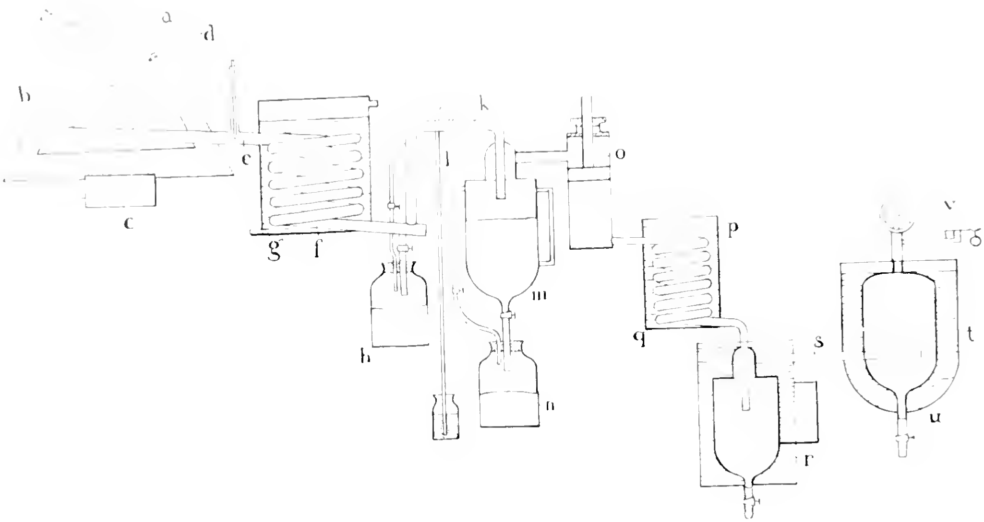


FIGURE 89. Dr. O. Silberrad's Isoprene Apparatus.

[illegible]

[illegible] CH . CH.CH [illegible] CH [illegible] CH [illegible] CH CH/CH

CH [illegible] Cl

[illegible] chloride. Methyl divinyl or Isoprene + HCl

The methods of producing isoprene from common substances of a more complex nature, whilst not exactly syntheses of this substance, are, however, of more importance commercially.

It was some time ago that Sir William Tilden discovered that isoprene could be obtained by passing turpentine through an iron tube heated to a dull red heat; but the yield was very small, being only about six per cent. Dr. Silberrad[*] finds that the yield is very greatly increased if the turpentine is heated under such conditions that the vapour is produced in a highly rarefied condition.

about 450°C. in the case of silver, or 30°C. higher in the case of copper, otherwise the isoprene is converted largely into dipentene.[†]

The latter chemist has also patented a very interesting method of converting carbohydrates, such as cane sugar, starch or cellulose (sawdust) into isoprene[‡], as follows: The carbohydrate is first converted into laevulinic acid by boiling with dilute hydrochloric acid. To this substance are added one and a half parts of phosphorus trisulphide, and the mixture heated in a retort to 130°–150°C. A violent reaction takes place, and thiotolene ($CH_3 - C_4H_3 = S$) is produced, thus.

CH₂ CH [illegible] PS [illegible] CH = CH

CH [illegible] CO [illegible] CO.OH → CH = C [illegible] CH

Laevulinic acid [illegible] S
Thiotolene

[*] English Patent, 1910, No. 4,001. O. Silberrad, Ph.D., *Improvements in the Manufacture of Isoprene.* Our thanks are due to Dr. Silberrad for a photograph and particulars of his apparatus not given in the English Patent Specification.

[†] English Patent, 1910, No. 14,040. A. Heinemann. *Improvements relating to the Production of Isoprene.*

[‡] English Patent, 1908, No. 13,252. A. Heinemann. *A Process for Converting Carbohydrates into Hydrocarbons.*

Phosphorus pentasulphide may be used in place of the trisulphide, in which case thiotenol is obtained instead of thiotolene.

CH CH

CH — C C.OH

S

The thiotolene or thiotenol is converted into isoprene by reduction with hydrogen, effected by passing a mixture of either compound with hydrogen over finely-divided copper or iron at a temperature of 300°–500°.

CH CH CH

CH — C CH + 2H = CH — C + H_2S

S CH CH_2

The ring breaks at the point indicated, the sulphur first combines with the metal, and the resulting sulphide is then reduced by the hydrogen, giving sulphuretted hydrogen, the above equation showing the final state of affairs. Above 500° C the isoprene is converted into dipentene.

Drs. W. H. Perkin and C. Weizmann have patented[1] a process for preparing isoprene from amyl alcohol. Two parts of the latter are allowed to stand with one part of zinc chloride for twenty-four hours and then distilled. This process eliminates the elements of water from the amyl alcohol, and the resulting amylene is converted into isoprene by passing through a heated tube. Thus:

$$C_5H_{11}.OH - H_2O = C_5H_{10} = C_5H_8 + H_2$$

Amyl alcohol. Amylene. Isoprene.

A good deal of work is still being expended on the problem of the inexpensive production of caoutchouc by artificial means, and further results may soon be expected. As to whether the synthetic article will ever prove a dangerous rival to natural rubber it is not possible to say.‡ Doubtless, in course of time, increasing numbers of natural products will be replaced by substances identical in all their properties but chemically prepared; doubtless, also, synthetic caoutchouc (which at present is in its merest infancy) has a future before it and will one day play a part in helping to meet the already enormous and rapidly increasing demand for india-rubber. But there is no cause for fear of any decay in the rubber-growing industry on this account.

[1] U. S. Patent. No. 991,453. W. H. Perkin and C. Weizmann, *Process of Manufacturing Isoprene.*

‡ In this connexion we must bear in mind that it is not without the region of possibility that natural rubber may owe some of its valuable properties to the intimate mixture with the caoutchouc of the small quantity of other substances present. Tests to settle this question and to determine whether the synthetic, chemically-pure caoutchouc (as obtainable at present) is really physically identical in all respects with the natural article, do not appear to have been carried out.

SOLAR DISTURBANCES DURING JANUARY, 1912.

By FRANK C. DENNETT.

Adverse weather has much hindered Solar study during the past month. At the same time the Sun has preserved a condition of almost unruffled quietude to the telescopic observer. Only on one day, January 5th, some faculic flecks showed near the limb in the south-eastern quadrant, and so not far from longitude 25° to 35°. They looked like the remnants of an outbreak. As the exact position was not measured it is impossible to present the usual diagram this month.

The progress of the cycle of solar phenomena is best shown by the table of observations during the past eleven years. It gives the number of days on which the Sun was observed, also the number when spots were seen or faculae only, and those when there has appeared to be a clear disc.

Year	Observations	Spots	Faculae only	Clear
1901	251	49	...	...
1902	270	56	35	179
1903	338	280	43	15
1904	331	329	2	0
1905	345	343	2	0
1906	351	346	5	0
1907	350	350	0	0
1908	343	337	5	1
1909	342	340	2	0
1910	343	278	48	17
1911	332	155	90	87

The consideration of these figures lead to the expectation that the time of minimum will occur at the end of the present year or early in 1913. The decrease of activity was earliest noted in the northern hemisphere, and therefore the earliest return may naturally be expected there.

The eclipses of the Sun on April 17th and October 10th, should be of special interest, as, occurring at a time of minimum, the corona may be expected to present what is known as a winged appearance. The poles of the Sun are marked by short sharp plumed rays, whilst the coronal matter is extended into elongated streamers in the equatorial regions. It would appear probable the winged circles which figure so largely in Egyptian temples, and so on, were designed from such a phenomenon. The corona usually seen at the time of maximum, as in 1905, is quite different, the polar plumes being absent, and the coronal rays appearing to radiate in all directions instead of being confined to the equatorial regions.

Another feature noticeable at the time of minimum is that the prominences are fewer in number, and many forms which are of frequent occurrence in times of activity are almost if not entirely absent. Helium may always be observed in the chromosphere as a bright orange line known as D_3. Frequently it may also be observed as a dark line amid spot groups, and over faculae. During 1909, 1910, and 1911 the observers who co-operate in producing this monthly report have recorded the presence of this dark line on 112, 85 and 35 times respectively, decreasing with the decrease of activity.

The observers who contributed the material for the present page were Messrs. J. McHarg, A. A. Buss, L. [illegible] Peacock, W. H. Izzard, and the writer, at widely scattered stations, yet they only succeeded in seeing the Sun on twenty-one days throughout the entire month.

Errata.—In the February number, page 59 in [illegible] and 3rd lines from the bottom read 28 instead of [illegible]

THE FACE OF THE SKY FOR APRIL.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun. R.A.	Dec.	Mercury. R.A.	N.Dec.	Venus. R.A.	Dec.	Mars. R.A.	N.Dec.	Jupiter. R.A.	S.Dec.	Saturn. R.A.	N.Dec.	Uranus. R.A.	S.Dec.	Neptune. R.A.	N.Dec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 9.

Date.	Moon. P	Mars. P	B	L	Q	q	Jupiter. P	B	L_1	T_1	L_2	T_2	Saturn. P	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 10.

Greenwich Civil Time (day beginning at midnight) is used throughout these notes: *m*, *e* are used to denote morning, evening respectively. P denotes the position angle of the axis of the body measured eastward from the N. Point of the disc. B is the Helio-(planeto-)graphical latitude of the centre of the disc. L denotes the longitude of the centre of the disc, and T the transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I of longitude refers to the Equator, System II to the Temperate Zones. To find intermediate values of T apply multiples of $24^h\ 39\frac{1}{2}^m$, $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$, for Mars, Jupiter I, Jupiter II respectively. Q, q for Mars are the position angle and amount of the greatest defect of illumination.

THE SUN continues its rapid northward march, and by April 21st has attained half its maximum North Declination. It rises at Greenwich at $5^h\ 38^m$ on April 1st, $4^h\ 36^m$ on April 30th; sets at $6^h\ 30^m$ on April 1st, $7^h\ 18^m$ on April 30th. The semi-diameter diminishes from 16′ 1″ to 15′ 54″.

THE MOON is Full April $1^d\ 10^h\ 5^m$ *e*, L.Q. $9^d\ 3^h\ 24^m$ *e*, New $17^d\ 11^h\ 40^m$ *m*, F.Q. $24^d\ 8^h\ 47^m$ *m*, Full May $1^d\ 10^h\ 19^m$ *m*. Apogee April $10^d\ 1^h$ *m*, semi-diameter 14′ 48″; Perigee $22^d\ 10^h$ *e*, semi-diameter 16′ 12″. Greatest libration 5° W April 3^d, 7° S 9^d, 5° E 16^d, 7° N 23^d, 5° W 30^d. The letters indicate the region of the limb (considered with reference to our sky) carried into view by libration. Observers should take advantage of favourable libration for studying the region near the limb.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912			h m		h m	
Apr. 2	B.A.C. 4554	7·8	—		0.43 *e*	354
„ 3	86 Virginis	5·0	1.27 *m*	114	2.40 *m*	313
„ 6	Antares	1·3	6.26 *m*	46	—	—
„ 9	B.A.C. 6525	6·2			3.48 *m*	277
„ 11	B.A.C. 7237	6·2	—	—	4.51 *m*	242
„ 21	B.A.C. 1848	5·0	6.57	30	7.34 *e*	328
„ 21	136 Tauri	4·6	7.51 *e*	115	8.47 *e*	253
„ 21	B.A.C. [illegible]	6·1	10.47	93	11.30 *e*	275
„ 23	47 G[illegible]	5·6	[illegible]	[illegible]	1.40 *e*	200
„ 23	[illegible]	6·1	7.10	[illegible]	8.27	203
„ 23	[illegible]	6·2	[illegible]	150	8.40 *e*	241

TABLE 11. Occultations of stars by the Moon visible at Greenwich.

PARTIAL ECLIPSE OF MOON, APRIL 1ST. First contact with penumbra $7^h\ 55^m$ *e*; First contact with shadow $9^h\ 26^m$ *e*, 187° from N.Pt. to E., Mid Eclipse $10^h\ 14^m$ *e*, one-sixth of disc eclipsed; Last contact with shadow $11^h\ 3^m$ *e*, 235° from N.Pt. to E., last contact with penumbra Apr. $2^d\ 0^h\ 34^m$ *m*. The outer part of the penumbra has no visible effect, the inner part produces a smokiness on the disc. This eclipse is visible throughout Europe and Africa, in Western Asia and Eastern America.

ANNULAR-TOTAL ECLIPSE OF THE SUN, APRIL 17TH.—Details of the central line across Europe of this interesting eclipse were given last month. It is the largest solar eclipse in the British Isles since that of March, 1858, of which it is a return after the triple Saros. That was the third of three annular eclipses in Great Britain at eleven-year intervals.

The line where the magnitude is $\frac{9}{10}$ of the Sun's diameter runs from Cape Clear through Tipperary, Greenore, Downpatrick, Wigtown, Edinburgh, Fifeness. The $\frac{9}{10}$ line begins at Start Point, and runs just south of Oxford and King's Lynn. The largest eclipse in the British Isles occurs on the coast from Dungeness to Dover, where [illegible] of the Sun's diameter are covered. The smallest occurs in the Island of Lewis, where the magnitude is [illegible]. It [illegible] mentioned that the central line of the annular eclipse [illegible] Lewis.

The following table gives particulars of the eclipse for various British Stations. The times are Greenwich time except for Ireland, where they are in Dublin time. The letters *m*, *e* are not inserted, as they can [illegible] be [illegible], the eclipse being in the middle of the day.

	[illegible]	[illegible]	Glasgow.	Edinburgh.	[illegible]	Dublin.	[illegible]	Oxford.	[illegible]	[illegible]
First contact	[illegible] 24	[illegible] 23 [illegible]	[illegible] 54m	[illegible] 55 [illegible]	[illegible] 5	[illegible] 55 [illegible]	[illegible] 5 [illegible]	[illegible] 51 [illegible]	[illegible] 52 [illegible]
Angle from North Point	221	222	222	223	2[illegible]5	224	227	228	2[illegible]8
Angle from Vertex	24[illegible]	242	238	237	[illegible]42	2[illegible]	244	244	24[illegible]
Greatest eclipse	[illegible]	[illegible] 30m	[illegible] 16m	[illegible] 11m	[illegible]	[illegible]	[illegible]	[illegible] 11	[illegible] 11
Magnitude	[illegible]780	810	780	8[illegible]	847	838	8[illegible]	[illegible]02	[illegible]
Last contact	[illegible] 57 [illegible]	[illegible] 58	[illegible] 20m	[illegible] 28 [illegible]	[illegible] 27	[illegible] 3	[illegible] 20	[illegible] 3	[illegible]
Angle from North Point	66	65	67	66	6[illegible]	[illegible]4	[illegible]	58	5[illegible]
Angle from Vertex	55	53	54	52	4[illegible]	47	[illegible]	29	[illegible]

The angles are measured from North Point or Vertex towards the East. The partial eclipse is visible in Eastern America, throughout Europe, Northern Africa, and Western and Central Asia.

Mercury is fairly well placed as an evening star at the beginning of the month, setting in England about 1¾ hours after the Sun; diameter 9", ½ of disc illuminated. It is in inferior conjunction on the 15th. It is 3½° West of the Sun during the eclipse on the 17th, but being such a thin crescent will scarcely be seen. At the end of the month southern observers will see it as a morning star; diameter 10", ⅕ of disc illuminated.

Venus is still a morning star, better placed for southern observers than in England. Her diameter diminishes from 11" to 10", 11/12 of the disc are illuminated. She will be some 20° South-west of the Sun during the eclipse, and will doubtless be readily discernible in all places where the eclipse is large.

Mars is an evening star. Its disc is becoming too small for useful work. The diameter diminishes from 6" to 5". It is 20' South of ε Geminorum on April 21st.

Jupiter is now well away from the Sun, and favourably placed for southern observers. The polar diameter increases from 38" to 41". The equatorial is 2[illegible]" greater. Defect of illumination ¼". The diagram shows the configuration of the four large Satellites at 2h *m*, for an inverting telescope.

Day	West.	East.	Day	West.	East.
Apr. 1	4	[illegible]2	Apr. 16	[illegible]2	3
„ 2	21	43	„ 17	2[illegible]	13
„ 3	2 ⊙	34	„ 18		423 1●
„ 4		1324	„ 19	[illegible]	21
„ 5	31	24	„ 20	[illegible]2	[illegible]4
„ 6	32	[illegible]4	„ 21	[illegible]	4
„ 7	3[illegible]	4 2●	„ 22	[illegible]	124
„ 8		3124	„ 23	1 ●)	34
„ 9		43	„ 24	2	[illegible]34
„ 10	21	13	„ 25	[illegible]	2[illegible]
„ 11	4	1●	„ 26	3 ⊙	42
„ 12	43[illegible]	2	„ 27	[illegible]	[illegible]
„ 13	4[illegible]2	[illegible]	„ 28	[illegible]	[illegible]
„ 14	43[illegible]	2●	„ 29	[illegible]	[illegible]
„ 15	43	[illegible]2	„ 30	[illegible] ●)	[illegible]

Phenomena visible at Greenwich [illegible] unless marked e): I. Ec. D. 2d 3h [illegible]; I. Sh. I. [illegible]; I. Tr. I. 1h 36m; I. Sh. E. 2h [illegible]; I. Tr. E. [illegible] 49m; I. Oc. R. 4d 1h 9m; III. Sh. I. 4h 4[illegible]; II. Sh. I. 5d 4h 32m; II. Oc. R. 7d 3h 31m; III. Oc. R. 8d 1h 17m; I. Ec. D. 9d 5h 16m 26s; I. Sh. I. 10d 2h 22m; I. Tr. I. 3h 25m; I. Sh. E. 4h [illegible]5m; I. Tr. E. [illegible]; I. Oc. R. [illegible]; I. Tr. I. [illegible]; III. Tr. E. [illegible] 15d 0h 5[illegible]; III. Tr. E. [illegible]; III. Oc. R. [illegible]; II. Tr. I. [illegible]; I. Sh. I. [illegible] 4h [illegible]; I. Ec. D. 18d 1h [illegible]; I. Tr. I. [illegible]; I. Sh. E. 1[illegible]; I. Tr. E. [illegible]; I. Oc. R. [illegible]; II. Ec. D. [illegible]; III. Ec. D. 22d 3h [illegible]; III. [illegible] 4h 10m 30s; II. Sh. I. [illegible]; II. Tr. I. [illegible]; II. Sh. E. 1h 58m; II. Tr. E. 3h 20m; I. Ec. D. 25 [illegible]; I. Sh. I. 26d 0h 57m; I. Tr. I. [illegible] 26m; I. Sh. E. 2h 51m; I. Tr. E. 3h 38m; I. Oc. R. 27d 0h 58m; II. Sh. I. 30d 1h [illegible]; II. Tr. I. 2h 2m; II. Sh. E. 4h 12m.

Saturn may still be seen as an evening star, but is drawing near the Sun. It is 25° East of the Sun on the 17th, and may be seen on the central line of the eclipse.

Uranus is a morning star, still badly placed.

Neptune is an evening star, still within the limits of the map given in "Knowledge" for December.

Meteors. The following radiant points are due to Mr. W. F. Denning.

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. to May	263	62	Rather swift.
Apr. 12 to 24	210	10	Slow; fireballs.
„ 10 to 25	30[illegible]	23	Swift, streaks.
„ 18 to 23	180	31	Slow, long.
„ 20, 21	201	36	Swift, bluish-white.
„ 22 to 22	271	33	[illegible]
„ 20 to 25	218	[illegible]1	Slow, long paths.
„ 3[illegible] ...	201	5[illegible]	Rather slow.
Apr. — May	[illegible]03	58	Slow, yellow.
Apr. — May	206	+ [illegible]	Swift, streaks.

Minima of Algol (period 2d 20h 49m), every third minimum given. April 1d 11h 14m e, 10d 1h 41m e, 19d 4h 8m *m*, 27d 6h 35m e.

Clusters and Nebulae.

No.		R.A.		Dec.	Remarks.
H [illegible]	46	11	5	N [illegible] 2	[illegible]
M	97	11	9	N 55 [illegible]	[illegible] 3 [illegible]
H I.	27[illegible]	11	12	N 50 [illegible]	[illegible]
H I.	271	11	13	N 58 [illegible]	[illegible]
[illegible]	[illegible]	11	15	N [illegible]	[illegible]
H I	[illegible]04	11	2[illegible]	N 44 2	[illegible]
H I	[illegible]73	11	48	N 37 [illegible]	[illegible]
H I	[illegible]	12	5	N [illegible]	[illegible]
H V	[illegible]3	12	14	N 47 [illegible]	[illegible]
H I	[illegible]	12	10	S [illegible] 2	[illegible]
M	85	12	2[illegible]	N [illegible]	[illegible]
H I	[illegible]2	12	31	N 2[illegible]	[illegible]
H I.	84	12	40	N 2[illegible]	[illegible]
M.	[illegible]4	12	52	N 2[illegible] 3	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	41		White, [illegible]
[illegible]		[illegible]	[illegible]	[illegible]	5	Yellow, [illegible]
[illegible]	[illegible]	[illegible]		147	7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	Yellow, [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	151	[illegible]	Yellow
[illegible]	[illegible]	[illegible]		[illegible]	5	White, [illegible]
[illegible]	[illegible]	[illegible]		21		[illegible]
		[illegible]	[illegible]	234	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	331	[illegible]	White
			[illegible]	148	21	
[illegible]	[illegible]	[illegible]	6. 8	321	2	White, [illegible]
Σ 579	[illegible]	N 47	6. 8	38	4	White, [illegible]
		[illegible]	[illegible]	114	63	
[illegible]	[illegible]	N 22 [illegible]	[illegible]	278	4	White, [illegible]
[illegible]		[illegible]	[illegible]	[illegible]	1	White
Σ [illegible]	[illegible]	[illegible]	[illegible]	250	1	White, [illegible]
[illegible]	[illegible]	[illegible]	5. [illegible]	274	[illegible]	Yellow.
[illegible]	[illegible] 7	[illegible]	5. 3	325	6	Yellow.
[illegible]	[illegible]	[illegible]	[illegible]	85	1	Triple.
				125	20	
[illegible]	[illegible]	[illegible]	5. 5	227	20	Yellow.
Σ [illegible]	2 [illegible]	[illegible]	[illegible] 5	327	21	Yellow, [illegible]
Σ [illegible]	[illegible]	N 54	[illegible] 8	284	3	White, [illegible]

THE TINTS AND SHADES OF AUTUMN WOODS.

By P. Q. KEEGAN, LL.D.

(*Continued from page* 51.)

What then is the specific cause of the autumnal red colouration of the forest leaf? It is undoubtedly produced similarly to that of the red petal (see January number of this journal, page 15), the albuminoid molecule is disrupted, but not because there is a violent demand for its nitrogen and phosphorous elsewhere (*i.e.*, in the pistil), as in the case of the floral organ. No, the disruption of autumn ensues because the cell plasm gradually loses its vitality; nitrogen becomes deficient, but it is not drawn away, nor is it reproduced *in loco*; there is a different chemism because there is a change of nature of the plasm, and so long as it still lives it can do with less nitrogen, the nitrogenous content of forest litter being in all these special cases comparatively small. Moreover, behold also a most interesting difference! The physiological processes going on in stamens and pistils in connection with fecundation and reproduction are so vigorous and powerful that special and peculiar tannoid chromogens are produced in the petals, which frequently evolve extremely vivid and brilliant pigments. But this is not the case with the fading glories of the woodlands. The autumn leaf is far too feeble and exhausted to permit of any such demonstration of energy. The tannoid of its early life is gradually, as the summer months elapse, converted into tannin, which, moreover, may have a different chemical composition and constitution from that which the flower of the same plant evolves, or may evolve. Thus, in the petals of Foxglove, and so on, tannoids are found which are utterly absent in any of the other organs at any period of their existence.

On the other hand, where, as in the yellow, brown, and russet leaves, the albuminoid becomes insoluble and passive and remains permanently stored up, as it were, there is no special deassimilation thereof; its chemical transformation has ceased, and hence there is no fresh production of tannin and pigment. Hence the brown shades may be regarded as a mere decomposition product, dull and dead, which ultimately impregnates the dry coagulated cell-contents massed against the equally lifeless cell-wall. We have already seen how this phenomenon coincides with a high percentage of total ash containing a very high percentage of silica; which means that the inert physiological condition has permitted the encroachment of all this encrusting matter more especially upon the epidermal cells, the very spot where under other conditions the brilliant autumn tints are specially evolved.

ON THE RESEMBLANCE OF THE FLORA AND FAUNA OF IRELAND TO THAT OF THE SPANISH PENINSULA.

By R. F. SCHARFF, Ph.D., B.Sc., F.L.S.

THE late Edward Forbes long ago drew attention to the remarkable fact that in the south-west and west

FIGURE 90.

The Spotted Slug (*Geomalacus maculosus*) and a Map showing its distribution.

of Ireland there exists an assemblage of plants which do not occur elsewhere in the British Islands, although apparently native in the north of Spain. Several writers have subsequently commented on this feature in the Irish flora. Not many plants belong to this "Lusitanian element" in our flora, yet they are sufficiently recognisable to have attracted the notice of every observant botanist who has visited Ireland. Since Professor Forbes wrote his well-known essay on this subject,[*] a few species of plants unnoticed by him have been added to this Lusitanian flora; and what is more remarkable, it has been discovered that there are also a few animals which possess a similar geographical distribution. This peculiarity in the Irish flora and fauna has thus acquired quite an exceptional interest among naturalists. One of the most conspicuous plants in the neighbourhood of Killarney, in the south-west of Ireland, is the Strawberry-tree (*Arbutus unedo*), a beautiful evergreen bushy tree, bearing in the early winter pretty red globular berries, which have given rise to its popular name. Frequently cultivated in gardens in the south of England, it only grows wild, outside the Irish boundaries, in the Spanish Peninsula, along the borders of the Mediterranean and in the extreme south-west of France. A much commoner plant, though less noticeable, is the well-known London Pride of English gardens (*Saxifraga umbrosa*). Like the last it is only native in Ireland, where it grows in abundance in many of the southern and western counties. On the Continent it is only known from the Spanish Peninsula and the Pyrenees.

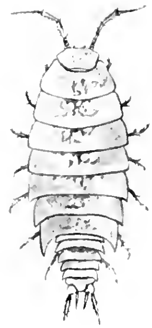


FIGURE 92.

Trichoniscus vividus, found in Ireland, Spain and the Pyrenees.

FIGURE 91.

Rhopalomesites tardyi and a Map showing its distribution.

A closely allied Saxifrage (*Saxifraga geum*), differing from the last in the shape of its leaves, has a similar foreign range, and is confined in the British Islands to the mountains of Kerry and Cork. The large-flowered Butterwort (*Pinguicula grandiflora*, see Figure 93)[†], has the same geographical

[*] Forbes, E.—"On the connection between the distribution of the existing fauna and flora of the British Is[illegible] the geological changes which have affected their area." "Geological Memoirs." Vol. I. 1846.

[†] I am indebted to my friend Mr. R. Welch, of Belfast, for the photographs illustrating th[illegible].

distribution in Ireland, whereas abroad it extends somewhat further east than the others do, as far as Switzerland.

Two beautiful heaths inhabit the western part of

FIGURE 93.
Large-flowered Butterwort (*Pinguicula grandiflora*), West Cork.

the counties of Mayo and Galway, and are found nowhere else in the British Islands. The first of these, known as the Mediterranean Heath (*Erica mediterranea*, see Figure 94), with its pretty flesh-coloured flowers, grows abundantly in Portugal and the north-west of Spain, while St. Dabeoc's Heath (*Dabeocia polifolia*, see Figure 95), with its elegant large pink bells, has the same range, which extends into south-western France.

Now among animals, as already remarked, we likewise possess similar instances of species confined to Ireland and the Mediterranean region, or the Spanish Peninsula. Most of these, however, exhibit a less marked restriction in their range to the western counties. Yet one of the best known examples, the Spotted Slug (*Geomalacus maculosus*, see Figure 90), has a geographical distribution in Ireland almost identical with that of the Strawberry-tree. On the Continent it is apparently peculiar to northern Spain and Portugal.

In Dublin and in the south and west of Ireland a large spider is frequently noticed, which seems to replace to some extent the common house spider. It has been named *Tegenaria hibernica*, and is not known from Great Britain, though it is closely related to, and perhaps identical with, the Pyrenean *Tegenaria nervosa*.

Among the wood-lice there are several species belonging to the same Lusitanian group. The claret-coloured *Trichoniscus vividus* (see Figure 92), for example, occurs only in Spain and the Pyrenees, as well as in the south of Ireland. Finally, two species are confined in Ireland to the Hill of Howth on the east coast. These are *Metoponorthus melanurus* and *Eluma purpurascens*.

These are only a few of the more noteworthy examples of Lusitanian plants and animals occurring in Ireland and not in Great Britain or even in the north of France. It is quite evident, therefore, that the Lusitanian element in the Irish flora is more significant than Professor Forbes had imagined. And yet he argued on the strength of his own observations on the habitat of these plants, that the latter could not have been conveyed by either winds or marine currents to the stations they now occupy, which opinion has since been generally adopted by Irish botanists. When we take into consideration the presence in Ireland of such a slug as *Geomalacus maculosus*, which could certainly not have been carried to Ireland by any of the known means of accidental transport, and whose eggs can neither float in sea-water nor be wafted across the ocean from Spain by winds, the problem is not so readily solved as some recent authorities seem to imagine. It has been

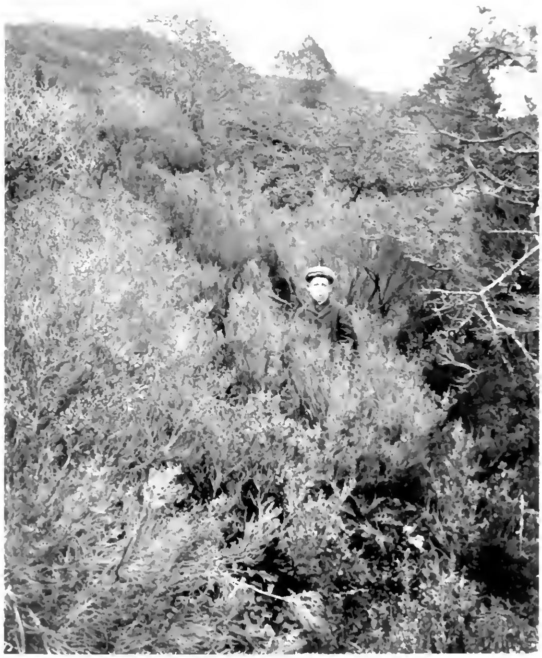


FIGURE 94.
The Mediterranean Heath (*Erica mediterranea*).

suggested, indeed, by several writers that the Lusitanian element in the Irish flora is due to ordinary accidental causes, such as winds and ocean currents.

Figure [illegible].

St. Dabeoc's Heath (*Dabeocia polifolia*). Roundstone.

When we survey the fauna and flora of the British islands as a whole, we find that there are quite a number of Lusitanian plants and animals that are not confined to Ireland, but inhabit also the south of England. A few species have even invaded the west of Scotland, although they seem to occur, as a rule, more abundantly in Ireland than in Great Britain. Among such plants may be mentioned the Irish Spurge (*Euphorbia hiberna*, see Figure 96) which grows very abundantly in the south and west of Ireland, while it is also met with in a few isolated spots in Devonshire. As an instance of a Lusitanian animal belonging to this group, the beetle *Rhopalomesites tardyi* (see Figure 91) may be cited. This weevil is so common in Ireland that it is classed among the most injurious Irish timber insects. In Great Britain it is only known as a rare insect in the south-west of England and Scotland.

Hence, we now know that the Lusitanian element in our fauna and flora, though much more conspicuous in Ireland, is not peculiar to that country. This fact greatly weakens the arguments in favour of accidental dispersal. To anyone, moreover, who has made a careful study of the mode of occurrence of these plants and animals in the British Islands, it must be apparent that they are old-established species, most of which are being crowded out or supplanted by newer rivals better fitted to withstand the existing [illegible] conditions. Th[illegible] a discontinuous [illegible] which, as W[illegible] taught us, is [illegible] antiquity. M[illegible] occur here a[illegible] in isolated patches [illegible] distri[illegible] [illegible]

Figure [illegible].

The Irish Spurge (*Euphorbia hiberna*). Kerry.

Professor E. Forbes, in discussing the origin of the Lusitanian species which he thought were confined to Ireland, suggested that Spain and Ireland were once directly connected with one another by land, and that this provided a safe northward passage for a number of southern species. The existing Irish members of the Lusitanian element he looked upon as the last survivors of this ancient invasion of the northern territory, contending that this event must have taken place in Miocene times long anterior to the Glacial Epoch, when the land in Western Europe stood higher than it does now.

One of the principal difficulties which Professor Forbes' view presents to us is that, if these plants wandered northward in pre-glacial times, they must have survived the Ice Age in these islands. The natural question also occurs to us, could specific identity have been preserved in so many instances during such an immense lapse of time from the Miocene to the present age?

There is no doubt, however, that we have still a good deal to learn about the Ice Age and its supposed climatic conditions. Much remains quite obscure to the present day as to what actually happened during this phase of geological history. At any rate it cannot be definitely asserted that the Lusitanian fauna and flora could not have survived the Ice Age in Ireland. As for the persistence of specific identity through several geological periods, there are some instances known to us where this can be proved to have occurred. It is possible that all the species I have alluded to may have survived from Miocene times to the present day, though we possess no palaeontological evidence for such a supposition. All the same, a better explanation of the presence of these animals and plants in the British Islands than the one suggested by Professor Forbes, seems to me to be that they wandered northward not by a direct connection between Spain and Ireland, but along the west coast of Europe at a time when the British Islands formed part of the Continent, and that most of them subsequently became extinct in the intermediate area when the conditions grew less favourable for their survival. As I have indicated in another place, I quite agree with Professor Forbes that this event must have happened before the Ice Age.[1] Some species may be of Miocene age, others are possibly older or younger. We have no means, in the present state of our knowledge, to determine this factor, but the whole problem forms one of the most interesting chapters connected with the origin of our fauna and flora. Patient observation and study will in time furnish us with its correct solution.

[1] Scharff, R. F. "European Animals; their Geographical History and Geographical Distribution." London, 1907.

THE RESEARCH DEFENCE SOCIETY.

It is the work of the Research Defence Society to put before the public, and keep before the public, the facts about experiments on animals in this country, and the great benefits which have been obtained by the help of such experiments. These benefits are not limited to men, women and children; the animal world also enjoys the advantages gained by experiments on animals. It is better protected against the scourging epidemic diseases, such as anthrax, rinderpest, bovine tuberculosis, and equine lockjaw; the causes and way of infection of such diseases as Nagana and Texas cattle fever have been discovered and proved; good advance has been made toward a protective treatment against distemper; and admirable tests have been discovered for the detection of tuberculosis in cattle and glanders in horses.

The Research Defence Society was formed in 1908, to remind people what a great national debt of gratitude we owe to experimental physiology and pathology. It began with seven members, and it already has more than five thousand members and associates, and has established Branch Societies in all parts of the Kingdom. It has nothing to do with the actual making of experiments on animals, nor with advising the Home Office over applications for licenses and certificates under the Act; nor does it desire the abolition of restriction of such experiments in this country. Its work is to publish and distribute literature, to answer all enquiries, to make all necessary arrangements for debates, and to give addresses and lantern lectures all over the country. The minimum subscription for working expenses is five shillings; but undergraduates and students of medicine are eligible for membership at an annual subscription of half a crown. Larger subscriptions or donations will be gladly received. Associates pay a subscription of one shilling.

Of course, the Society wants more members and associates. The work keeps growing, and the more it grows, the better the Society is pleased. There is an endless amount of work to be done. Many of the public know next to nothing about the general character and purpose of experiments on animals at the present time. The common use of the word "vivisection" hides the fact that ninety-five per cent. of all experiments on animals, at the present time, in this country, are inoculations, or of the nature of inoculations; that is to say, they involve no sort or kind of cutting operation on any animal. Neither is it known to everybody that no operation, more than the lancing of a vein just under the skin, is allowed to be done on any animal in this country, unless the animal, through the whole of the operation, is under some anaesthetic strong enough to prevent it from feeling pain.

When we consider what measureless and permanent gains have been made by mankind, and by the animal world, out of the work of such men as Pasteur and Lister, we see the good of a Society set apart for the one purpose of keeping the public in mind of the facts of the case. These facts have been in past years obscured, now and again, by prejudice, or by something worse than prejudice. It is the business of the Research Defence Society to popularise the whole subject. As Bacon said of man, that he is the interpreter of nature, so this Society might call itself the interpreter of the interpreters. That would be a fine motto for it: "Interpres Interpretum Naturae."

We hope that many of the readers of "KNOWLEDGE" will communicate with the Honorary Secretary, 21, Ladbroke Square, London, W. He will be very glad to hear from them.

THE KNOWLEDGE OF THE DEAD NAPOLEON

BY A. M. BROADLEY.

Author of "Napoleon in Caricature," etc., etc.

A CAREFUL study of the various forms of pictorial satire relating to Napoleon in connection with my book "Napoleon in Caricature," led me incidentally to collect and examine the numerous portraits (some of them obviously more or less caricatures), which were made between July, 1815, when he went on board the "Bellerophon," and his death at Longwood, nearly six years later. A series of happy accidents

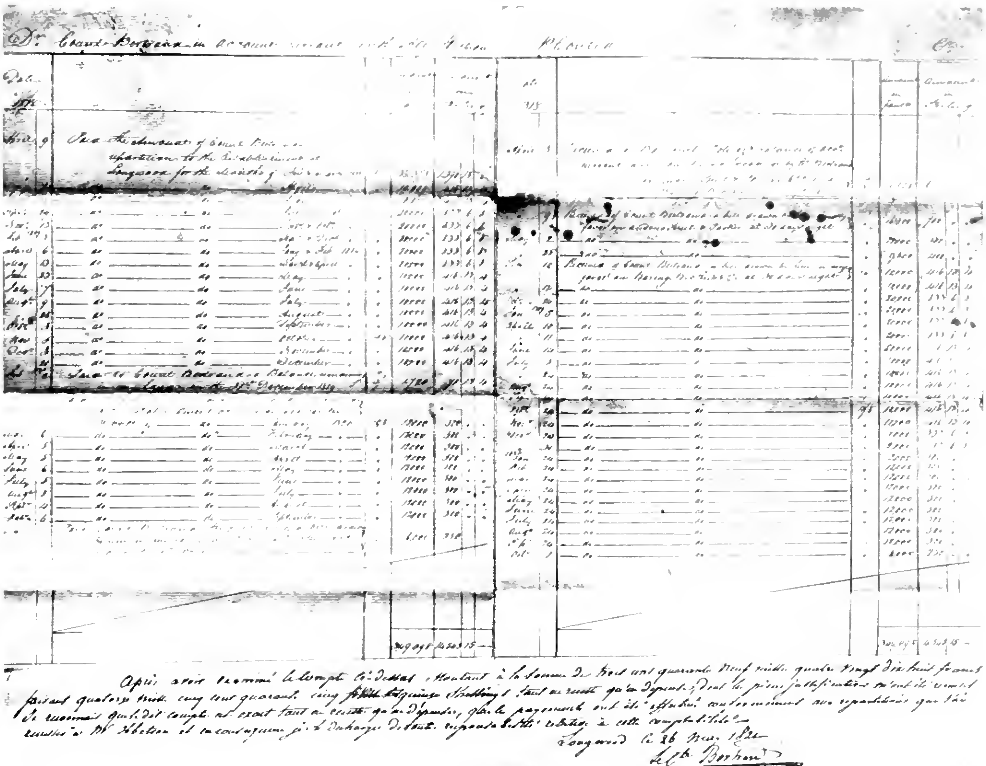


FIGURE 97.

The adjustment of accounts from March, 1818, and October, 1820, made three weeks after Napoleon's death, between Assistant Commissary Ibbetson and Count Bertrand, now in the possession of one of Ibbetson's descendants.

enabled me to identify as the principal of the St. Helena portraitists, Mr. Denzil Ibbetson (1775–1857), an officer of the Commissariat, who joined the department as a clerk in June, 1808, and attained the rank of Deputy Assistant Commissary-General in October, 1810. On Christmas Day, 1814, he was promoted to be Assistant Commissary-General, and in the following year proceeded to St. Helena on board the "Northumberland," upon the deck of which ship he made his first sketches of the Great Man. Mr. Ibbetson's term of St. Helena service, according to the official record, dates from July 28th, 1815, to June 27th, 1823. On the resignation of Mr. Balcombe he became "Purveyor to the Household at Longwood, near which house he took up his abode. He was with Napoleon at the time of his death, made a sketch of him as he lay dead, superintended the sale of his effects, and afterwards drew up the general statement of accounts now reproduced for the benefit of future historians of the last phase. (See Figure 97.) The life-story of Denzil Ibbetson, written by me and illustrated by a large number of his unknown and unpublished sketches of Napoleon and his companions in exile, now in my collection, will be published in the April number of *The Century Magazine* of New York. One of the portraits of the Emperor made on board the "Northumberland," given by Ibbetson ... before

Hook, in 1817, and attested by him, was reproduced in facsimile as one of the chief illustrations in

Figure 98.
Napoleon after death, from the finished oil-painting by Assistant Commissary-General Denzil Ibbetson, in possession of Mr. A. M. Broadley.

M. Frederic Masson's recently-published monumental work on St. Helena. It also appeared in my own work, "Napoleon in Caricature." Much valuable information concerning Mr. Ibbetson, who retired from the public service on June 15th, 1846, with the grade of Deputy Commissary-General, and died at Brighton eleven years later, was given me by Lady Ibbetson, the widow of his distinguished grandson, the late Sir Denzil Charles Jelf Ibbetson, K.C.S.I., of the Indian Civil Service. Her husband's aunt, Miss Laura Ibbetson, the youngest daughter of the Purveyor at Longwood, still lives, and amongst other valuable relics of Napoleon owns one of the oil-paintings of the dead Emperor, which Mr. Ibbetson subsequently made from his original sketch of May 6th, 1821. My present concern is solely with the posthumous masks and portraits of Napoleon, and there can be no doubt but that Ibbetson enjoyed special facilities for securing a good likeness. That he was capable of executing a good drawing his "Northumberland" portrait sufficiently shows.

Figure 99.
Lithograph published in 1855, after one of Deputy Commissary-General Ibbetson's paintings, in which the artist is erroneously described as "Captain Ibbetson, R.E."

The Ibbetson oil-painting of the dead Napoleon measured about thirty inches by twenty-five inches. The one in my own collection now reproduced (see Figure 98) bears a lengthy inscription in Ibbetson's handwriting. Duplicates of this picture by Ibbetson are at Hampton Court, and, as before stated, in possession of Miss Ibbetson, and I have quite lately discovered that there exists a fourth, which for more than twenty years has belonged to a gentleman residing in Edinburgh, and is surrounded with an elaborate frame bearing the letter N in each corner. At the back of this particular replica of Ibbetson's portrait is a note by the artist similar to that on Miss Ibbetson's copy and on my own as follows: "Painted by D. Ibbetson from a sketch made by him (at St. Helena), of Napoleon, the morning after his death, which took place in the evening of 5th May, 1821, at sunset. The features had fallen away during his illness, but the fullness in the throat remained. The countenance was very placid, the colour of the skin very yellow, and there was a redness about the eyes which had the appearance as if the head had been beat and bruised. A picture similar to this was painted by the same person at St. Helena immediately after the sketch was taken, and was given by Sir Hudson Lowe, on his return to England after the death of Napoleon, to King George IV. This picture is now at Hampton Court, and it appears by a periodical work called *The Art Union*, that the performance of it is erroneously attributed to Madame Bertrand." The owner informs me that his picture measures two feet four inches by nineteen and one-eighth inches. It is in fairly good condition. The Hampton Court copy is said to have been given by Sir Hudson Lowe to King George IV. In 1855 a lithograph "improved" from one or other of the four Ibbetson paintings, and now reproduced (see Figure 99), was published, but the artist, although still living, was erroneously

Figure 100.
Napoleon after death, published by S. and J. Fuller, 34, Rathbone Place, London, July 10th, 1821, and described as being lithographed from a sketch made by Captain Marryat fourteen hours after death at the request of Sir Hudson Lowe, and with the permission of Count Montholon and General Bertrand.

Figure 101.

Napoleon after death, from a water-colour on straw paper by a Chinese artist at St. Helena in 1821. In the collection of Mr. A. M. Broadley.

described in it as Captain Ibbetson, R.E.

Captain Frederick Marryat, R.N. (1792-1848) the well-known novelist, was, in June, 1820, appointed to the "Beaver" sloop which was employed on the St. Helena station till after the death of Napoleon. Marryat was also permitted to make a sketch of the illustrious exile as he lay dead on the historic Austerlitz camp-bedstead. Of this drawing he made and signed several replicas in pen and ink and wash; one of these is now my property. Marryat's posthumous portrait of Napoleon was almost immediately published in England, Germany and France. On the English version we read:—"Sketch of Bonoparte, as laid out on his Austerlitz Camp Bed, taken by Captain Marryat, R.N., fourteen hours after his decease, at the request of Sir Hudson Lowe, Governor of St. Helena and with the permission of Count Montholon and General Bertrand." The drawing must have been sent to London almost as soon as the despatches announcing Napoleon's demise, for it was brought out by Messrs. Fuller, of Rathbone Place, on July 16th following. (See Figure 100.)

Figure 102.

Pistrucci's lithograph of Napoleon after death. London, 1822-3.

In his admirable book, "A Polish Exile with Napoleon," Mr. G. L. de St. M. Watson says: "It was on May 6th, at 8 a.m., that Marryat sketched, with an austere frugality of line, his noted profile of Napoleon on the camp bed, which he gave to Captain Crokat, of the 20th Regiment, and which was published on July 16th by S. and J. Fuller, as a lithograph and also as an etching, and on July 18th by J. Watson as a soft-ground etching." Marryat quitted St. Helena in the "Rosario" on May [illegible]th.

There were two or three French editions of the Marryat plate. In that of 1840 the descriptive text reads: "Napoleon Gravé par W. Humphrey d'après le dessin fait à St. Hélène par le Capitaine Marryat, C.B., officier de la Légion d'Honneur, *une heure* après la mort de l'Empereur." In view of the wide-spread distribution of these Marryat death-bed portraits it is almost incredible to relate that the presence of one of the sketches in a local museum was quite recently proclaimed to be an event of almost world-wide importance. The picture was at once reproduced as a great historical and artistic discovery in a large number of London and provincial newspapers, to the astonishment and dismay of Mr. Clement Shorter and other students of St. Helena iconography. In the interests of true history, I addressed the following letter to *The Times*, in which the "latest Napoleonic find" had been duly announced: "There are several authentic portraits of Napoleon after death in existence practically identical with that reported to have been recently discovered at Maidstone. One of these (signed by the artist) is in my collection. I have seen two others, and a fourth was lately in possession of a granddaughter of the artist. Lithographs after Marryat's sketch were subsequently published both in London and Paris. A similar drawing was made by Deputy

Figure 103. Death mask of Napoleon after Dr. Antommarchi. In the collection of Mr. A. M. Broadley.

Commissary Denzil Ibbetson (the grandfather of the late Sir D. C. J. Ibbetson), who was the author of a whole series of portraits of Napoleon executed between August, 1815, when Ibbetson first went out to St. Helena in the "Northumberland," and 1821, when he lived in a house near Longwood and acted as purveyor to the exiles."

A third posthumous portrait of Napoleon (see Figure 101) was made by a Chinese artist, who is said to have been employed as a cook on the Longwood establishment. A great many of these were executed on white satin, and sold as one of a series of six drawings. These sketches have recently fetched as much as £6.

FIGURE 104.

Napoleon as he appeared when his coffin was opened at St. Helena on October 15th, 1840, nineteen and a half years after his death.

It now only remains to speak of the two death-masks of Napoleon, one of which was taken by Dr. Antommarchi. A copy of this mask is shewn at the Invalides. Another (now reproduced) is in my own collection. Mr. Watson says that Burton took the cast after the Corsican doctor had failed. He has discovered a memorandum in the Lowe papers to the effect that "The Bertrand kept the face and

FIGURE 105.

Major Stewart's view of the "Briars," Napoleon's first residence at St. Helena (October–November, 1815), in which one of Ibbetson's interesting "back" portraits of Napoleon is introduced.

Dr. Burton the back or craniological part." A second cast was presumably taken by Dr. Arnott, and a copy of this, officially stated to have been presented by Arnott to John Gawler Bridge, Court Jeweller to George IV., was recently sold at the dispersal of the Bridge relics in Dorsetshire. It was stated at the time that "only two casts were taken at St. Helena, and the matrix destroyed. The other cast belongs to the French Government, and is in the Invalides at Paris." The first fact should be officially verified, as the second is erroneous. The cast in the Invalides is from the so-called Antommarchi matrix, not from that of Arnott. A little later (in 1822 or 1823) Pistrucci, of 30, Coventry Street, published a lithograph from a drawing of one or other of these masks, probably Antommarchi's, beneath which he placed the following inscription:

"After the death of Napoleon in the Island of St. Helena, General Bertrand ordered a Cast of Napoleon's Face to be taken whilst he lay dead. Genl. Bertrand when arrived in France had some Portraits taken from this Cast by Made. Jacotot, a Painter of Porcelaine at Sevres. From one of the said Portraits, now in the possession of Mr. Lewis Goldsmith of London, I have, with his permission made the present Lithographic Drawing, and composed the following lines in the native Language of Napoleon.

"Nacqui in Ajaccio, ma il destin che scrive
Dell'uom la sorte in l'ordin suo profondo
Mi trasse in Francia e sulle mille rive
Che varcai la bilancia ebbi del mondo
"Or mentre il nome mio superbo vive
Forse a niun altro in paragon secondo
Io morto son e mi ricopre appena
Un freddo sasso in quasi ignota arena"
"F. PISTRUCCI, 30, Coventry Street."

When the coffin of Napoleon was opened, nineteen

FIGURE 106.

Original water-colour sketch of Napoleon's Funeral (May, 1821), in Mr. A. M. Broadley's collection.

years later, prior to the removal of his remains to France, his features appeared to have undergone very little change, and they still attested the correctness of Ibbetson's death-bed sketch. (See Figure 104.) The last word about St. Helena has not been said, but much new light is thrown on the "Last Phase" by the work of Mr. G. L. de St. M. Watson, who, before writing his scholarly and instructive book "A Polish Exile with Napoleon," with exemplary patience went through the whole of the Lowe MSS. in the British Museum, as well as a mass of other new and valuable material.

THE GRAPHIC EXPRESSION OF SENSE.

PART II. PRINTING PROBLEMS.

By ANNA DEANE BUTCHER.

IN a paper read before an American Typographical Association, Mr. T. L. de Vinne, who is regarded as the most eminent of living printers, remarked that we make use of two distinct styles of printing, "Masculine," or that which is noticeable for strength and absence of ornament, and "Feminine," that which is characterised by delicacy, and by the weakness which always accompanies delicacy. . . . . "The object of the masculine style" he says, "is the instruction of the reader, and to this end the printer tries to show the intent of the writer by the simplest methods. . . . . . For this he relies most upon the plainness of his type, the blackness of his ink and the excellence of his paper."

In a scientific age this somewhat enigmatical description of two graphic methods of expressing meaning, leaves much to be desired, and may be interpreted thus:—

For "simple" read, "inadequate," for "strength" read "coarseness" and for "plainness of type" read "monotony of style, consequent upon the degeneration of the graphic symbols."

The antithesis of "delicacy" is not "strength" but "vulgarity," *i.e.*, the ignoring of delicate distinctions, inaccuracy of definition, and loose generalisations.

The triumphs of modern Engineering, of Chemistry, of Astronomy, and indeed all the developments of modern civilization are due to the science of Graphics, to the accurate notations of the mathematical and exact sciences, and to "delicacy" in all the graphic arts except that of the printer.

The delicacy of the balance is not weakness, strength is due to a nice adaptation of means to ends, it is measured by its capacity for work, and the progress of some sciences may be attributed to the observation of extremely fine differences in the form of minute organisms.

Astronomy is not the same science as it was before the invention of the telescope. Why should typography be the same as it was before the invention of the magnifying glass?

Print which had its genesis in the imitation of the forms of animate nature, should be developed along the same lines. The printed page should bear a comparison with animate nature, simple indeed to the superficial observer, and easily read, but upon inspection, revealing hidden meanings and affording more and more information to the student.

The leaf does not obtrude its structure and the arrangement of its veins and cells upon the passer-by, but repays investigation if the student will but stay and learn in Nature's school from the only teacher who is infallible.

Compare the delicate ramifications of the skeleton of the leaf under the magnifying glass with the coarse lines and empty spaces of the best specimen of the typefounder's art, and the contrast will strike the beholder with astonishment and lead him to reflect upon the way in which the lessons of Nature have been thrown away upon the masculine printer, who has lost the instinct of imitation as well as his visual imagination.

The object of an educational print is not that he who runs may read, but that by close investigation the letters and words may be photographed upon the brain, and be automatically reproduced by the hand after constant repetition.

The more information, then, that the idiograph gives about itself the better, and for its study a very excellent magnifying glass can be bought for the moderate sum of fourpence halfpenny.

To Mr. F. A. Bellamy's reasonable complaint that he has had to use twenty-five words to explain what the printer could have expressed by one letter, it is futile to answer: "That is true, but see how good is the paper and how excellent the ink!"

The final s is always pronounced as z in English and in French, when pronounced at all, and the additional vocal effort necessary to produce the hissing sound is logically expressed by an additional letter, "**as**"- "**ass**," "**is**" "**hiss**," differentiating to the eye the unimportant auxiliary words which are pronounced without any effort, from the important idiographs, which are stressed. This being the Englishman's normal vocal habit, the printer should indicate where he has omitted a letter by the sign of contraction ˎ as **us̀, thıs̀ —ous̀,** and so on, where the addition of a line from left to right downwards is understood to mark the contraction which so often occurs in his work: thus the letter j is logically printed = **dgȷ** and illogically printed with a dot **j, idg** = **iȷ**

It is not the desire of the printer "to instruct the reader," or the "simplicity of the means adopted by him," which causes constant confusion of meaning, and perpetuates the curse of Babel: it is rather the fact that while the Fundamental System of the Stars is "brought up to date," the printer remains four centuries behind, at the point in the history of writing when the typemakers and punchcutters usurped the functions of the scribes, arresting its natural development, and causing what should be a living and growing art to be crystallised, or rather fossilised, in the present notation.

Professor Leduc, who has chosen the accompanying extract for a specimen of the Orth[illegible]tion.

[illegible] Orthotype pronounce. In some [illegible] perfectly impossible to converse with [illegible] [illegible] theory of Orthotypic [illegible] speak English they cannot understand those who speak French the result is the same.

The [illegible] European idiography which illustrate [illegible] perfectly understandable by sight to [illegible] Englishman, and that without [illegible] into his own language, but [illegible] it is transposed from the ordinary print into English [illegible] sounds it is wholly incomprehensible.

By the help of a straight line in four positions, | – \ /, four segments of the circle, and the dot, (◡ ⌒) •, which geometrical elements are found in all letters and symbols and can be easily added to the print, the reader is enabled in half-an-hour, with the assistance of a Frenchman, to associate a certain **feeling** of vocal positions and movements with his visual impressions, and he has nothing more to learn about French pronunciation. By the same amount of repetition and practice which he willingly employs in order to be able to sing a simple tune or to play it upon the pianoforte, he will be able to transpose this extract into speech sounds, so that *any* Frenchman can understand Professor Leduc's meaning, without that mental distraction which is caused by constant reference to the context to discover what French words have been uttered.

The automatic assumption, by the vocal organs, of the positions indicated by the letters and signs, is caused by a function of the brain similar to that which guides the fingers and hands to the right keys of the instrument automatically, *not* by the conscious will of the performer, but by a subconscious telegraphic apparatus, which communicates from eye to tongue, and is called association of Sign and Sound.

After this one extract has been in this manner translated into speech sounds, any French book can be read out [illegible] without difficulty or hesitation, provided, of course, that it is properly printed, or corrected by the hand of the student or teacher.

Conversation being merely the reproduction of former impressions upon the brain, will by this system be regulated by the amount of literature which which has been perceived by the eye and ear, and automatically reproduced by the hand and tongue. All that is worth saying is to be found in the literature of the classical languages, and there is no advantage to be gained by learning to talk twaddle in more than one language, after the manner of conversation books, primers, and grammars.

The results of many experiments have proved the truth of the above statements. Even without understanding what they are reading, foreigners have been able to convey the meaning of a book by speech sounds to the complete satisfaction of a native without the help of phonetic spelling or transcription; the writer, for example, has read Spanish in this way.

The short extract from pages 102 and 103 of Professor Leduc's work, "The Mechanism of Life," contains out of two hundred and sixty-four French words, one hundred and eighty-four English, *i.e.*, international words which are easily recognised by sight.

Subtracting prepositions, pronouns, conjunctions and often repeated auxiliary words, such as form twenty-five per cent. of all European writing, we arrive by a rough computation at seventy-five per cent. or three-quarters as the proportion of French and English words which are international in scientific literature, and it is this European Idiography, as a means of universal communication and a basis of modern civilisation, which should command the attention of scientific men and at all costs be preserved from the destroying agency of the "*phonetic iconoclast.*"

The geometrical key which indicates the position of the vocal organs in producing the vowel sounds introduces no new element into print and can be learnt in five minutes.

While preserving the sequence of letters and number of component parts of the idiographs, upon the invariability of which legibility depends, the Orthotype Notation shows the pronunciation of European languages at a glance.

The juxtaposition of two letters or signs indicate invariable sounds caused by two positions of the vocal organs and their movements from one position to the other. In this way the printer's one hundred and four self-inconsistent ways of writing down thirteen English vowel sounds are brought into a logical and practical system.

The superscript dot	˙	is the dot of the letter	i	in
The superscript sign	(	is the back of the letter	e	hen
The sign "aw"	)	is the right hand convexity of the letter	ȯ	ȯr
The sign	'	is the perpendicular diameter of ...	ȯ	on
The sign	–	is seen in the serifs of	w	two
The sign	◡	is the letter	U	us
The sign	^	is the letter	A	Ah!
The sign	"	is the German	ű	

La paléontologie nous apprend que les premiers êtres sont apparus dans les eaux, les êtres les plus anciens des temps primaires qui, dans l'évolution des êtres vivants, représentent une période plus longue à elle seule que toutes les autres réunies, étaient tous aquatiques. D'autre part, tous les êtres vivants sont constitués surtout par des liquides par des solutions de cristaloïdes et de colloïdes, séparés par des membranes osmotiques à travers lesquelles s'affectuent de perpétuels échanges. Enfin les mers actuelles les vastes laboratoires de la vie sont également les solutions de cristaloïdes et de colloïdes. C'est donc dans l'étude des liquides dans l'étude des solutions, que l'on doit découvrir la nature et l'origine de la vie.

La vie est un ensemble de fonctions, de transformations énergétiques qui se présentent à nous comme les résultantes de la forme, ce la structure de la composition des êtres vivants, c'est à dire des formes extérieures, intérieures, et moléculaires des êtres vivants. Tous les êtres vivants sont formés de cavités closes, remplies de liquides, solutions de cristaloïdes et de colloïdes, limités par des membranes osmotiques. Le premier pas dans l'étude de la vie et de son origine doit donc être l'étude des forces et des circonstances physiques capables d'organiser ainsi les liquides, de donner des cavités closes entourées de membranes osmotiques d'associer de grouper ces cavités, de les différencier, de spécialiser leurs fonctions dans l'évolution de l'ensemble. Ces forces et ces circonstances physiques ce sont précisément celles qui donnent les croissances osmotiques, et nous avons vu que celles-ci avaient non seulement la structure, la forme extérieure d'un grand nombre d'êtres vivants, mais encore les principales fonctions de la vie. De toutes les opinions qui ont été formulées sur les origines de la vie et des êtres vivants, celle qui attribue les origines de la vie à l'osmose, et qui considère les premiers êtres comme des productions osmotiques, est de beaucoup la plus vraisemblable, la plus satisfaisante pour la raison.

Nous avons vu qu'aux temps primaires et secondaires, les mers qui couvraient notre globe devaient présenter à un haut degré les conditions favorables aux productions osmotiques; pendant ces périodes incommensurables, il a du nécessairement se produire dans toutes ces mers des végétations osmotiques, exubérantes; toutes les substances donnant au contact des membranes osmotiques, sels solubles de calcium, phosphates, carbonates, silicates, aléolins, matières albuminoïdes, ont du s'organiser en productions osmotiques, naissant se développant évoluant se dissouant; des millions de formes éphémères ont du ainsi se succéder pour donner la nature actuelle dans laquelle le monde vivant représenterait la matière ainsi organisée par osmose.

Lorsqu'on se livre à l'étude expérimentale de la morphogénie osmotique, que l'on voit les substances les plus communes, les plus repandues à la surface de la terre et dans les êtres vivants; les sels de calcium les carbonates, les phosphates, les silicates, s'organiser, se développer, croître, affecter des formes nombreuses et variées, analogues à celle des êtres vivants, on ne peut pas concevoir que, pendant toute la durée du passé de la terre, ce phénomène ne se serait jamais produit; au contraire la conviction s'impose irresistible, que l'osmose a eu nécesairément un role prépondérant dans l'histoire et dans l'évolution de la terre et de ses habitants. Quand, après cette étude expérimentale et la conviction qu'elle impose, on interroge la science, on ne trouve aucune mention du role de l'osmose dans l'histoire naturelle de la terre, aucune recherche de ses effets, la science est muette, comme si l'osmose n'avait joué aucun role, comme si ce phénomene physique n'existait pas.

The authority for the French pronunciation is the "Dictionnaire Phonétique," by H. Michaelis, Paul Passy, and M. Gaston Paris, Administrateur du Collège de France.

͡ denotes [illegible] ‿ denotes [illegible] ´ [illegible] ` denotes [illegible]

ɛffàcêăble	is‿it pūre	mùsic	màres	
effacablê	ɛst‿il pur‿	musique´	mɛ̀rs	mɛ̀res

) = ȯ	ı = o	− = w,ơ,ư	(= ɛ = aı	‿ = e, u	^ = a
ȯr	hȯnɛst	yơu, wɛ	ɛ́re, (fan)	humble, murder	pass
ȯr	hȯnnête	vơus, ơui	fɪ̀ɲ, aɪs	humble, meurtre	passe

= i, i, y	= ı	= ɛ, ï	= y
ill, primary,	indict, idëă	machïne, marïne	yȧwl, opinion
il primaırês,	origine, petit	machine vïvaɲt	yȯle opinioɲ

The following French sounds have no exact equivalent in English.

a = ı = laboratoıre, moı, patte, pȃrt. e = é dépĕɲdaɲt (dɛpɛ́ndant)

u lune, (lūnar, mōōn), du, (dūe). ″ = u lűi, (Lơuie), pűis.

= au role, (ròll), au, auteur, (ȧuthor) = aɲ ĕɲ, daɲs, ɲ = n.

CORRESPONDENCE.

ABOUT THE TRISECTION OF AN ANGLE.

To the Editors of "KNOWLEDGE."

SIRS,—The division of an angle into three equal parts forms, together with the quadrature of the circle and the duplication of the cube, the three most renowned problems of Greek mathematics. As its algebraic expression leads to an irreducible equation of third degree, its construction cannot be made by using only the line and the circle. Knowing that, one must be sure that the solution given by Mr. C. S. Bingley in the November number of "KNOWLEDGE" (page 435) cannot be right. Mr. C. S. Bingley asserts, without any demonstration, that (using his signs) the distances BJ = JK = KC, and from this concludes that the arc BC is divided by J and K into three equal parts.

Now, it is easy to see that this is not true. By taking AD and its perpendicular in A as axes of rectilinear coordinates, and supposing AB = AC = 1 and the angle BAC = 2α, the coordinates of E will be $(\frac{1}{2}, 0)$, and so will be B $(\cos\alpha, \sin\alpha)$, I $(\frac{1}{4} + \cos\alpha, \frac{1}{2}\sin\alpha)$, H $\left(\frac{1}{8} + \frac{\cos\alpha}{4}, \frac{\sin\alpha}{4}\right)$. J being on the line AH and on the circle BC will have the coordinate $\left(\frac{5 + 2\cos\alpha}{\sqrt{29 + 10\cos\alpha}}, \frac{2\sin\alpha}{\sqrt{29 + 10\cos\alpha}}\right)$, instead of $\left(\cos\frac{\alpha}{3}, \sin\frac{\alpha}{3}\right)$ which would be when the construction is exact. By denoting the angle JAD with δ, the following table shows the error of the construction for α = 10°, 20°, 30°, 40°. The angle [illegible] been computed by $\cot\delta = \frac{5 + 2\cos\alpha}{2\sin\alpha}$ [illegible]

α	10°	20°	30°	[illegible]
$\frac{\alpha}{3}$	3° 20′	6° 40′	10°	[illegible]
δ	2° 51′ 10″	5° 40′ 40″	8° [illegible]	[illegible]

The difference $\delta - \frac{\alpha}{3}$ is, as we see, [illegible] is not only due to errors "in the drawing."

BUDAPEST. ERNEST [illegible]

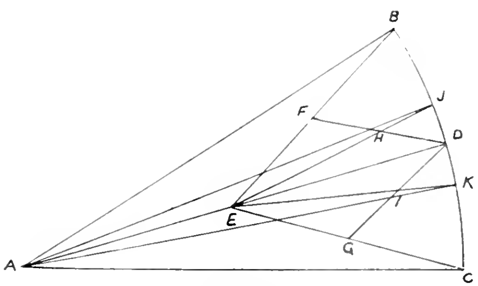


FIGURE 107.

THE SPECTROSCOPIC ASPECT OF THE IMPACT THEORY.

To the Editors of "KNOWLEDGE."

SIRS,—I have not had the opportunity of examining and comparing in detail the several spectroscopic observations of Novae as regards the correspondence between them and the deductions of the theory, but it appears to me that the main phenomena are sufficiently striking, and that the general agreement, providing as it does the fundamental working hypothesis, endows the details with an increasing interest. Novae have presented to astrophysicists some of the most bewildering problems in the whole of astronomy. Their sudden appearance, followed by declining luminosity and the extraordinary characteristics of their spectra, defied explanation. Yet in their spectra (considered in conjunction with telescopic observations), was written the secret of their origin. It behoves us to remember that Professor Bickerton's beautiful generalisation was conceived and worked out at a time when observational confirmation was meagre, and this should increase our respect for it in the light of subsequent discovery. I doubt if Professor Bickerton himself ever imagined to what extent his early conception would be enriched and strengthened by continued observation and discovery.

The spectra of Novae are of supreme interest; they tell of matter in the crisis of extreme stress, matter under conditions which we cannot reproduce in the laboratory; and every small detail in them is worthy of close study. All these details may not yet be capable of explanation, but the main phenomena are met by the theory of the third body, and it is surely most logical to adopt as a working basis the one theory which explains the most characteristic features of such spectra.

Without attempting to discuss the various other aspects of the theory from the standpoint of general astronomy, we may consider briefly these spectroscopic phenomena on their own merits. The first circumstance which strikes the attention is the emergence from the general blaze of the Balmer series of hydrogen lines, but not as we are accustomed to see them either in the laboratory or in normal stellar spectra. They are wide bands with diffused edges. This appearance has been sufficiently emphasised in Professor Bickerton's own writings, and his explanation of it as a necessary deduction from his theory appears to me to be the only one possible.

In an examination of the spectrograms, we notice that the width of the bands increases as we proceed along the series towards the violet. This is a necessary consequence of prismatic dispersion, as will be evident by plotting the dispersion curve of any spectrogram giving the normal hydrogen series in a stellar comparison spectrum, e.g., the Stonyhurst spectrogram of Nova Persei with that of α Geminorum as a reference spectrum. Therefore, to measure the amount of widening, it is necessary first to ascertain accurately the form of the dispersion curve representing the varying degree of dispersion under which the several lines are presented.

Although great pressure will widen lines, rendering diffuse lines which are normally sharp, it is clearly quite incapable of explaining the widened lines of Novae for the reasons given so clearly by Professor Bickerton in "KNOWLEDGE" (September pp. 365, 366), namely, that the bands remain sensibly constant and bordered on the more refrangible edges by dark absorption lines. In passing it may be interesting to note that in accordance with the Doppler principle, spectrum lines should be widened by reason of molecular motions in a source in a state of high thermal disturbance, but this effect is very small even at high temperatures.

It is, I think, very desirable that all available spectroscopic observations of Novae should be collected and discussed on the basis of the theory of the third body, especially as regards the careful comparison and reduction of all spectrograms. According to the theory, the extreme edges of the widened lines represent the maximum velocities in the line of sight towards and away from the earth of the gaseous shells of the elements to which such lines are spectroscopically attributable. It is important to ascertain whether these velocities are what the respective atomic weights would lead one to expect; also whether lines of any one element all indicate by their measured displacements the same velocity. These and several other points require investigation, but there are many factors which have constantly to be kept in mind. One of these is the very important question of possible elemental dissociation. If this has been claimed for elements present in normal stars, subject to normal temperature conditions consequent on their locality, how much more must the possibility be considered in the case of the violent forces brought into play in stellar impacts. And if this dissociation occurs, then the velocity in the line of sight calculated from the displacement of one line of an element would not necessarily be the same as that deduced from another line normally attributable to the same element. If the third body as a whole be practically stationary in space, then the centres of the widened lines would coincide with the corresponding lines of the comparison spectrum; but if it should happen that there was considerable motion in the line of sight, a complicating factor would be introduced, for in addition to being widened, the lines would be bodily shifted. It will be seen that the detailed interpretation of such spectra is by no means an easy matter. The measurement of the spectrograms is in itself beset with difficulties on account of the diffused edges of the bands merging into a background of more or less continuous spectrum. Combined with this there is the question of blends, differing intensities of the lines, and the varying sensitivity of the photographic plate to light of different wave-lengths.

With reference to the displacement of lines due to the motion of the source in the line of sight, it should be pointed out that the magnitude of the effect varies with the wave-length of the line in question, the displacement corresponding to any given velocity being greater in the red than in the violet. If, then, we are considering a practically uniform dispersion like that given by a grating, the linear shift will be more apparent in the region of longer wave-lengths. The general formula for calculating the velocity in the line of sight from the observed displacement may be given as:—

$$v = V \frac{(\lambda_1 - \lambda_2)}{\lambda_1}$$

where V = velocity of light
λ_1 = normal wave-length of the line in question
λ_2 = the wave-length of the displaced line.

Since $\lambda_1 - \lambda_2$ represents the change of wave-length or displacement, the formula becomes:—

$$v = V \frac{d}{\lambda}$$

The displacement which would be produced in any given line by a given velocity in the line of sight is thus:—

$$d = \lambda \frac{v}{V}.$$

The linear shift corresponding to a given velocity is thus twice as great at λ 6000A° as at λ 3000A° when represented on a wave-length scale of equal parts, which is approximately the condition with grating spectrograms. In the case of prismatic spectra, we have the two effects of shift and dispersion acting in opposition, but the increasing dispersion in the region of shorter wave-lengths very much more than compensates for the decreasing line shift, hence the displacements appear more obvious with decreasing wave-length.

These are some of the circumstances which render the study of the spectra of novae a matter of considerable complexity, but of the general truth of the interpretation supplied by the theory of the third body I personally feel no doubt. It is probable that difficulties, apparent or real, may be encountered in matters of detail, but the theory which Professor Bickerton has formulated supplies a fertile, and I believe, a true basis for the future investigation of these remarkable celestial objects. Small discrepancies, or apparent inconsistencies when carefully investigated may throw unexpected light on the processes involved, for there must follow many problems involving conceptions of great interest to students of atomic physics, such, for example, as the stability of the elements referred to above.

EAST CROYDON. CHARLES W. RAFFETY.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE AXIS OF MARS. In "Knowledge" for last October, I described Dr. H. Struve's method of finding the position of the axis of Mars, and its compression, from the motions of the poles of the orbits of Phobos and Deimos. He has now published a revised result, including the observations of 1907 and 1909 (when there were many visual observations at the Lick Observatory, and photographic ones at Pulkowa). He obtains results very near his former ones, but entitled to considerably more confidence.

North Pole of Mars at epoch 1880·0 R.A. 317° 4′·4; Annual Increase 0′·463. N. Dec. 52° 35′·6; Annual Increase 0′·239.

Obliquity of Mars Equator to orbit, 25° 10′.

Polar compression $\frac{1}{190}$.

Centre of circle of Pole of Phobos orbit 317° 3′·7, N. 52° 36′·0.

Distance from Pole of Mars 0° 0′·6.

Radius of Circle 57′·5. Annual angular motion of Pole 158°.

Eccentricity of orbit ·017.

Centre of circle of Pole of Deimos Orbit 316° 1′·2, N. 53° 16′·0.

Distance from Pole of Mars 0° 55′·5.

Radius of circle 1° 44′·0. Annual angular motion of Pole 6°·371.

Eccentricity of orbit ·003.

I understand that these values will in future be used for the Ephemeris for Physical Observations of Mars.

THE FIGURE AND MASS OF URANUS. Mars is not the only planet for which the satellites give interesting information as regards its figure and the position of its axis. They are particularly valuable in the case of the two outer planets of our system, on whose surfaces it is difficult to detect any marking. Mr. Marth long ago recognised that the plane of the orbit of Neptune's satellite Triton was shifting, which is evidently due to the equatorial protuberance of Neptune. The motion is so slow (one revolution taking about five hundred and eighty years) that a longer time must elapse before the position of Neptune's axis is accurately known. A first approximation was given by the present Astronomer Royal and Mr. Edney, in *Mon. Not. R.A.S.* April, 1905. A more elaborate discussion by Mr. David Gibb (*Proc. Royal Soc. Edinb.* 1908-9) indicated that Neptune's North Pole is in R.A. 295°·6, N. Dec. 42°·8. Its equator in that case is inclined 21°·2 to the orbit of Triton, and 27° to its own orbit. In view of the probable retrograde rotation of Neptune it might be more proper to call the above Pole its South Pole. In the case of Uranus its nearest satellite Ariel, is only half as distant from its primary as Triton from Neptune. There would consequently be a much more rapid shift of the orbit plane if it differed from the equatorial plane of Uranus. As no such shift has been detected, it is certain that the two planes practically coincide. This is further shown by the fact that the planes of all the satellites are sensibly the same. For if they were inclined to the equator they would shift at different rates, and their agreement at the present time would be most improbable. Hence we may take the position of the axis of Uranus as known.

The R.A. of its North Pole for 1900 would be 75°·81; annual increase ·014; North Dec. 14°·79; annual diminution ·001. Orion is therefore the North Polar constellation for Uranus.

We cannot, as in the case of Mars, obtain the oblateness of Uranus from the shift of the orbit planes of the satellites, for no shift appears to exist. Dr. Oesten Bergstrand, Director of the Upsala Observatory, has endeavoured to determine it from the motion of the peri-uranium of the inner satellite Ariel. He has utilised the observations made at Lick Observatory since 1894. The orbit is so nearly circular that we cannot place great confidence in the result. He finds eccentricity of Ariel's orbit ·007, annual movement of peri-uranium 15°; the corresponding results for Umbriel are ·008, 4° or 5°. The value of the compression depends on the distribution of density in the globe of Uranus.

		Rotation Period H.
If Uranus is homogeneous the compression is	[illegible]	...
If it is arranged like Jupiter, the compression is	[illegible]	... 17·6
If it is arranged like Saturn, the compression is	[illegible]	... 11·3
Value adopted as most probable	[illegible]	... 13

It would seem, then, that Uranus takes distinctly longer to rotate than Jupiter and Saturn do, and the same appears to be the case with Neptune from the figures given above. It is perhaps not surprising, from the fact that they are intermediate in size between the giant planets and the terrestrial ones.

ROTATION OF VENUS. M. Belopolsky has recently published another spectroscopic determination of the period of rotation of Venus, which he again finds to be not very different from one day. It will be remembered that Professor Lowell's spectroscopic determination favoured the long period. Mr. Scriven Bolton has contributed a series of drawings to *The Journal of the British Astronomical Association*, which lead him to a period of 23ʰ 28ᵐ. Mr. McEwen adds a note recommending that too much weight be not given to this determination, owing to the extreme delicacy of the markings on Venus.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

CYCAD STEM STRUCTURE. The Cycadaceae, as the lowest group of Gymnosperms, and therefore of Flowering Plants, now living, are of such importance in the evolution of plants that every new detail discovered regarding their structure is of interest. In a recent paper, Chamberlain (*Bot. Gaz.*, 1911) has described the structure of adult stems of species of *Zamia*, *Ceratozamia*, and *Dioön*, and has considerably supplemented the information given by earlier writers. In *Dioon spinulosum* the wood zone in a plant six metres in height reaches a width of ten centimetres, far exceeding the extent of the wood zones previously described for any Cycad. This species shows a remarkable resemblance in detailed stem-structure to the Cretaceous fossil Cycad, *Cycadeoidea*, one of the members of the extinct family Bennettitales which were in some respects more primitive than the Cycads, and formed a link between this group and the remarkable Cycadofilicales or fern-like seed-plants. No growth rings ("annual rings") were found in the wood of *Zamia floridana* or *Ceratozamia mexicana*; *Dioon spinulosum* and *D. edule* have growth rings, which in the former species answer to the periods of activity which result in the formation of crowns of cones, but which in *D. edule* do not correspond to such periods. The protoxylem, or first-formed wood, consists of scalariform tracheids, from which there is a gradual transition to the tracheids with bordered pits, the latter forming the chief part of the wood. Scalariform tracheids are also found in the large medullary rays.

INK-CAP TOADSTOOLS. The small toadstools belonging to the genus *Coprinus* are remarkable in that the cap with its gills after a few days becomes converted into a black semi-fluid mass. The biology of these curious toadstools has been studied already by Buller in his brilliant "Researches on Fungi," but Weir (*Flora*, N.F., Band 3, 1911) has made a very extensive investigation of the genus *Coprinus* and disclosed many new and interesting facts in the physiology of these plants, and his long paper may be summarised as follows. In addition to the differentiation of the tissue into central conducting filaments and strengthening outer tissue, the stalk and gills contain a system of milk-tubes, and a connected system of air cavities is also developed, the whole offering an analogy with the arrangement of the tissues in one of the higher plants. The deliquescence of the cap is a kind of self-digestion, occurring quite independently of the action of bacteria and effected by a number of ferments which act upon proteins. The horn-like substance chitin occurs not only in the coats of the spores, but also in the outer tissue of the stalk and cap; the gills contain practically no chitin, and it is probably owing to this that the gills deliquesce more readily than the other parts of the fruit-body. Any part of stalk or cap is capable of regeneration, new fruit bodies being formed by this process; the plant shows definite polarity, there being greater power of regeneration in the side facing the substratum or turned from the light. Numerous grafting experiments were made, the young fruit-body of one species being grafted on the stalk of a different species; fusion took place between the threads of scion and stock, and the form of the mature fruit body showed evidence of reciprocal action between the two species; the spores, however, were not influenced by grafting. Similar grafting experiments were made with various fungi in addition to *Coprinus*, and in some cases Weir found evidence of reciprocal parasitism between the two species used.

Like Buller's work, this paper by Weir is perhaps even more notable as an indication of the interesting lines of research it suggests than for the actual results obtained by the writer, novel and striking as these results are in themselves.

PHOTOSYNTHESIS IN ALGAE.—It has long been known that the green pigment chlorophyll absorbs chiefly the red and blue rays of light. In plants possessing other pigments in addition to chlorophyll, the absorption spectrum is somewhat different. Dangeard (*Comptes rendus*, 1911) has now proved that even in green plants the infra-red rays are absorbed and utilised in growth, though there is apparently no absorption of the ultra-violet rays. Dangeard has also found that the blue-green algae (Cyanophyceae) are capable of utilising the infra red rays to a large extent. Meinhold (*Beitr. Biol. der Pflanzen*, 1911) has studied the Diatomaceae from this point of view, and finds that here, as in green plants, there are two maxima of assimilation, one being in the red and the other in the green-blue between lines C and F—not, as in green plants, in the blue between lines F and G. The results of experiments on assimilation, on being compared with those obtained by means of the spectroscope, show that the maxima of absorption and assimilation by no means correspond; that is to say, some of the rays which the plant absorbs are not utilised in photosynthesis, though they may be of importance in other processes of life.

BIOLOGY OF THE HORSETAIL (*EQUISETUM*).—In an interesting paper, Ludwigs (*Flora*, N.F., Band 3, 1911) gives the results of various observations and experiments he has made on the Horsetails (species of *Equisetum*). He finds that there is a characteristic difference between the leaves on the underground and aërial stems. The leaves of the rhizome, which persist much longer than those of the aërial stem, bear hairs on both sides; those on the upper side of the leaf serve to protect the delicate tissues of the growing-point, while the hairs on the underside secrete mucilage, making the growing tip of the rhizome slimy, and therefore helping it to push through the soil. On the aerial stem these hairs occur on the upper surface of the leaves, but not on the lower. Ludwigs finds that by suitable culture methods, the rhizome can be made to grow into an aërial shoot, and vice versâ; annual shoots may be made perennial; the normally colourless and unbranched fertile shoots of the field horsetail may be caused to develop chlorophyll and to produce branches; male prothalli can be changed into female, and vice versâ. Regeneration takes place when pieces of the shoot, or even of the prothallus, are cultivated; in the latter case, new prothalli grow out and may become detached. The author states, in opposition to Bower, that the nutrition of the developing spores is not due to the degeneration of some of the spore-mother-cells, but solely to the special nutritive layer or tapetum. He also describes the manner in which the antheridium opens to discharge the male cells; apparently the process resembles that seen in some mosses, there being a special cap or lid cell which is detached, after becoming mucilaginous and swollen.

THE "CALYX-TUBE" OF ROSACEAE.—The family Rosaceae shows great variety in the form of the flower, largely due to the varying degree of "perigyny" or "hemi-epigyny" exhibited by the flowers in the different genera. Hillmann (*Beih. Bot. Centralblatt*, Band 36, Abt. 1) has made a careful examination of the so-called "calyx-tube" or "receptacle-tube," for which he prefers the term "hypanth," and from his investigations on the anatomy of this tubular structure he concludes that in this family we have to deal with different kinds of tubular organs, which are not all formed in the same way. In the Rose, the tube is purely an axial structure, a hollow prolongation of the receptacle or top of the flower-stalk. In the Apple sub-family (Pomoideae), the "receptacle-tube" consists of both axis and calyx. In most of the remaining members of the family, however, the hypanth is the product of fused leaves. Hillmann believes that this is clearly shown by the structure of the flower in Avens, where the flower axis is prolonged above the cup-like outgrowth, and the latter can hardly be explained otherwise than as the product of congenital fusion of leaves.

EVOLUTION OF ALGAE.—In recent speculations on the evolution of plants, it has generally been assumed that the earliest vegetable organisms possessed chlorophyll and belonged to the green algae (Chlorophyceae). That these arose from green flagellates, while the brown and red algae arose probably from brown and red flagellates, appears to be supported by the discovery of transitional forms in each of the three series, green, brown, and red. Most writers on the subject, however, have assumed that whatever the course of evolution may have been, the green algae came first. This assumption has recently been combated by Brunnthaler (*Biol. Centralblatt*, 1911), who argues that in order to arrive at correct views regarding the phylogeny of the algae, it is necessary to take into account the probable conditions of life in the earlier periods of geological history. He rejects the view that there is any direct relationship between algae and flagellates, and regards the living forms of the latter as the termination of an ancient series of organisms, of which the earliest members may, however, have given rise to the red algae.

According to Brunnthaler, the most ancient algae are the red forms, or Rhodophyceae, and he bases this view upon the following arguments. The earliest plants must have been marine free-swimming forms; the absence of free-swimming forms among the present-day red algae indicates the great age of the group. Again, the red colour is an adaptation to life in the deep sea and in the dim light of the primitive world with its dense cloud canopy, for the red pigment enables the plant to absorb the green rays in which that light is rich. The ancient lineage of the group is further shown by the absence at the present day of primitive types in the red algae, and by the absence of motile reproductive cells as well as of free-swimming species.

The brown algae (Phaeophyceae) came next, according to this view, arising partly from brown flagellates and partly from red algae. That this is a younger group is indicated by the extraordinarily diverse structure of the reproductive organs, the constant presence of swimming reproductive cells, and the adaptation of the brown pigment to absorb rays from light more closely approaching that of the present world, but still with an atmosphere richer in water-vapour than that of to-day. In the meantime, the primeval red algae had become adapted to the dim ancient light, and therefore became restricted to the depths of the sea, leaving the upper waters as an open field for the evolution of the brown seaweed population when the latter appeared.

The green Algae (Chlorophyceae) are the youngest group of algae to appear in the succession. Their green colour is an adaptation to the clear light of later times, and they evolved in part from the recent flagellates and in part from the red algae. The early forms were marine, but after taking possession of the upper waters of the sea and invading estuaries, they became adapted to life inland in fresh water.

Whether or not this ingenious theory of Brunnthaler's gains much acceptance among botanists, it must be admitted that it has the merit, conspicuously absent in various other speculations on the evolution of plants, of taking into account the probable conditions of life in ancient times.

EVOLUTION OF THE FLOWER. In the *New Phytologist* (1911, Nos. 5 to 8) there are two further instalments of the interesting paper on "Floral Evolution, with particular reference to the Sympetalous Dicotyledons," by H. F. Wernham. The first two articles in this series have already been summarised in "KNOWLEDGE" (1911, pages 231, 277).

Engler's group Pentacyclidae includes the cohorts or orders Ericales, Primulales, and Ebenales. After discussing the general characters of the Ericales (including the large family, or natural order, Ericaceae, and five other smaller families), we find the somewhat startling suggestion that the Bilberry tribe (Vaccinioideae) should be removed from the Heath family altogether. It is true that the *Vaccinium* tribe differs from the rest of the Ericaceae in having an inferior ovary, but in modern systems of classification the position of the ovary is regarded as being of relatively small importance in deciding affinities, and it appears very unlikely that botanists will be inclined to follow Wernham in making even a separate family of Ericales for the *Vaccinium* tribe, much less in regarding them as having had an entirely different origin. It is suggested that while the remaining Ericales probably arose from the ancestral Ranalian (Buttercup-like) stock along the line which led to the Geraniales, the Vaccinioideae had their origin from the line which led from the same ancestry to the Rosales. In a course of lectures on Systematic Botany which has recently been given in the University of London, and of which it is hoped to include a summary in "KNOWLEDGE" shortly, Dr. C. E. Moss dissented from Wernham's theory regarding the position of the Vaccinioideae, while agreeing warmly with his views on the evolution of the Gamopetalae in general, and pointed out that if the Vaccinioideae are to be severed from the Ericaceae, the *Arbutus* tribe (Arbutoideae) must necessarily go along with them. Since the two sections (Vaccinioideae and Arbutoideae) agree in all essential characters, excepting that the ovary is superior in Arbutoideae, and the Arbutoideae are admittedly related very closely to the remaining sections (Ericoideae and Rhododendroideae) of the family Ericaceae, the result of the adoption of Wernham's revolutionary proposal would be an unnatural and, in fact, chaotic arrangement.

Apart from this criticism, one can have nothing but praise for the careful and brilliant working out of Wernham's views regarding the origin of the various groups of Gamopetalae (Sympetalae) from different groups of lower Dicotyledons (Archichlamydeae or "Polypetalae"). He, of course, adopts the theory that the Primulales have descended from the large group Centrospermae, which includes such well-known families as the Chenopodiaceae and Caryophyllaceae, and gives a "family tree" illustrating the details of the descent according to his views. Here we feel on much safer ground, though further work on the development of the flower in the various families is, naturally, required before the detailed course of evolution can be traced.

The Ebenales are less familiar to the British botanist than the two preceding cohorts, since this group consists almost entirely of tropical trees. The view is put forward, and worked out in some detail, that the Ebenales have arisen from the Parietales, hence the three cohorts dealt with are regarded as having arisen independently "by the grafting of sympetaly upon at least three archichlamydeous stocks—the geranial, the centrospermal, and the parietalian."

In his fourth paper, the author begins upon the large series of cohorts grouped under the name "Tetracyclidae," in which the floral organs (sepals, petals, stamens, carpels) are each confined to a single whorl, as compared with the Pentacyclidae in which there are two whorls of stamens and therefore five whorls in all of floral parts. The Contortae comprise the families Asclepiadaceae, Apocynaceae, Oleaceae, Gentianaceae, and so on, few of which occur in Britain. The ancestry and affinities of the Contortae present great difficulties; the floral structure is remarkably constant throughout the cohort and is of a relatively advanced character, and the Contortae "have left no traces of their progress from polypetaly to sympetaly in the shape of pentacyclic forms; neither a second staminal whorl nor any hint of it ever occurs." Still, it is suggested that the group may have arisen from the Geranial stock, like the Ericales. "While the latter have employed their evolutionary powers, so to express it, in the direction of specialization of habit and details of floral structure, the Contortae have reserved their efforts for the realization of the economy tendency." In tracing the detailed affinities of the Contortae, Wernham points out the isolated character of the two orders Oleaceae and Salvadoraceae, which agree with each other and differ from the remaining families of Contortae in so many striking respects that the author is led to regard them as deserving the rank of a special cohort, for which he proposes the name Jasminales.

CHEMISTRY.

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

CANADIUM: A NEW ELEMENT.—An account of a supposed new element, to which the name of "canadium" has been assigned, is given by Mr. A. G. French in a recent issue of the *Chemical News* (1911, CIV, 283). It was discovered in association with platinum and other metals of the platinum group, in the trap-dyke of the Nelson District of British Columbia, its quantity ranging from a few grains to about three ounces per ton of its companions.

The new metal, which is found in the form of grains or scales, is white and possesses a brilliant lustre. It melts at about the same temperature (964° C.) as silver, and is not so hard as platinum, ruthenium, palladium or osmium. Like platinum, it is not altered by being heated in the air, or by exposure to a moist atmosphere. It is not affected by iodine, hydrogen sulphide or solutions of sulphides, but is dissolved by nitric or hydrochloric acid. Unlike silver, it is not precipitated from its solutions by alkali chlorides or iodides.

PHOTOGRAPHIC EFFECT OF CHEMICAL REACTIONS.—A discovery, which appears likely to have far reaching effects, both in theory and practice, is described by Messrs. Matuschek and Nenning in the *Chemiker Zeitung* (1912, XXXVI, 21). It has been found that chemical reactions of the most different kinds produce light waves, or that part of the heat energy developed during the reaction is transformed into light energy.

In the striking series of experiments described, a beaker, to the bottom of which was fixed a star of tin-foil, was placed upon a sensitive plate in the dark, while the interacting substances were placed within the beaker. After several hours the plate was developed, and in each case a sharp image of the star was obtained. For instance, strips of various metals, such as zinc, copper, tin and lead, were suspended in sulphuric, hydrochloric or nitric acids, and notes were taken of the periods of exposure necessary to obtain sharp outlines of the star.

The distance of the reacting bodies from the sensitive plate and the nature of the surface of the metal had an influence upon the results; and the smaller the chemical affinity of the acid for the particular metal, the less the intensity of the photographic action, and the longer the time required. Thus, in the case of the metals and acids mentioned above, four days were necessary to obtain a sharp image in the reaction between lead and nitric acid. The treatment of copper oxide or hydroxide with acids, or of caustic alkali with water, gave analogous results. A thin layer of quicklime or of calcium carbide when spread on a glass plate with [illegible] tin foil [illegible] compound [illegible] later, proved markedly capable [illegible] dine plate. The formation of the [illegible] also developed the active [illegible] of sodium metasilicate by [illegible] markedly rapid in this respect.

[illegible] taking place in the hardening of Portland cement [illegible] setting of plaster of Paris and water [illegible] in about three days.

[illegible] the possibility of devising an [illegible] method of measuring and comparing the [illegible] chemical reactions. They may also [illegible] certain observers have found that rays emitted by the human body would affect a photographic plate [illegible], while others have been unable to confirm the occurrence of the phenomenon. In the light of these experiments, it would not be surprising to find that the [illegible] ceaselessly proceeding in the body should manifest their activity photographically much more rapidly in the case of one person than another.

BLEACHING OF FLOUR AND ITS EFFECT ON DIGESTION.—The latest addition to the controversy as to the harmlessness or the reverse of the artificial ageing of flour by means of bleaching is the paper contributed to the *J. Ind. Eng. Chem.* (1911, III, 912) by Messrs. Wesener and Teller. Of the various methods that have been proposed for bleaching flour, only those in which oxides of nitrogen are employed have proved commercially successful, and experiments upon the digestibility of the treated flour have therefore centred upon the latter.

In the present communication the results, which are given in detail, show that nitrites do not interfere with the digestion of starch by diastase, even when present in the proportion of 0·1 per cent. Nor is the process of pancreatic digestion checked either by nitrites in a relatively large amount or by protein which has been treated with nitrous acid or nitrites in not excessive quantity; while in peptic digestion nitric or nitrous acid may take the place of the hydrochloric acid naturally present. At the same time attention is drawn to the fact that it has never been proved that commercial bleached flours contain either nitric or nitrous acids, or mineral nitrites, and that, hence, results obtained with these acids and their mineral salts are not necessarily conclusive. Apparently, however, the oxides of nitrogen enter into direct combination with the colouring matter of the flour during the bleaching process, and the resulting compound gives the nitrite reactions. Physiological experiments have shown that the compound is not poisonous, and that it has no perceptible effect upon the blood.

PARAFFIN OIL FROM A YORKSHIRE COAL SEAM.—There are few recorded instances of the occurrence of paraffin oil in British coal seams, and the chemical composition of the oil in these cases has seldom been ascertained. Particular interest thus attaches to the account given by Dr. Cohen and Mr. C. P. Finn (*J. Soc. Chem. Ind.*, 1912, XXXI, 12) of the oil discovered in a seam in the Hemsworth Collieries, from the position of its occurrence and its bearing upon the theory of the formation of petroleum oil.

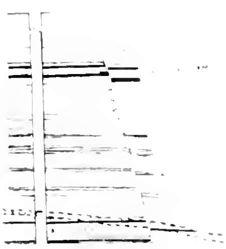


FIGURE 108.

The oil was found in the Haigh Moor seam at a point six hundred and ninety yards from the surface, where the road from the bottom of the pit crossed a fault which displaced the strata in a downward direction to a (maximum) extent of eleven feet. Subsequently more oil was discovered in a drift made early last year, the strata about the line of the fault being saturated with a yellow liquid, which became dark brown on exposure to the air. These strata, the position of which is indicated in the accompanying diagram, consisted of blue stone bind interspersed with iron-stone bands, and intersected with soft white sandstone. Apparently there had been no formation of natural gas at this point.

The oil collected for examination was a dark brown semi-solid material, which on fractional distillation yielded a series of fractions ranging from a light mobile yellow oil boiling below 150° C., to semi-solid dark yellow products boiling above 300° C. The constituents of these fractions were very similar to the hydrocarbons of petroleum products of high boiling point and suggested a common origin. Possibly the oil had been formed in strata beneath the coal seam, and, finding its way through the fissure of the fault, had condensed in the cooler upper strata.

Nothing in the nature of the coal itself pointed to its being the source of the oil, nor were there any signs of the intrusion of igneous rock, which in the heated condition might have caused destructive distillation of the coal.

Assuming this oil to have a petroleum origin, a difficulty is created by the absence from the strata of any fish remains, such as are usually associated with the occurrence of petroleum. Possibly deposits of cannel (in which aquatic remains are frequently found) might have had some connection with the formation of the oil. Yet, although there were such deposits in the vicinity of the coal seam, the oil was only found in the neighbourhood of the fault.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

EROSION IN THE HIMALAYAS.—In addition to the ordinary agents of denudation, others more irregular and abnormal are brought into play in great mountain regions. Dr. Arthur Neve enumerates three of these exceptional factors in a paper on Himalayan Erosion (*Geogr. Journ.*, October, 1911). Many of the great valleys of the Western Himalayas contain huge ancient riverine or glacial deposits, two thousand to three thousand feet thick, through which the present rivers have cut their way. This material is so loose and unstable that even in a dry climate, such as that of Lower Baltistan and Gilgit, landslips are constantly occurring; while torrential rains, as may be imagined, have an enormous effect in this direction. The erosion due to the landslips themselves is supplemented by that of floods caused by the cataclysmal outbreak of water dammed up by landslip débris or by glaciers. These floods cause tremendous erosion in the main valleys. Some sixty-nine years ago, according to one account, a vast landslip blocked the Indus river below Bunji, submerging the valleys for a length of thirty-six miles. A similar block, this time due to glaciers, occurred in the Suru valley in 1896. The burst, when it came, devastated the fields and villages for forty miles below.

The last of these abnormal factors of erosion is the effect of earthquakes in initiating the operation of landslips and floods. In the earthquake areas of the Himalayas, the soils of the hillsides and plateaux are split and crevassed, large and small landslips happen, drainage is thereby diverted or blocked, and the streams later burst out with destructive force. Dr. Neve gives an impressive picture of the enormous erosive forces at the command of nature in great mountain regions such as the Himalayas.

NEPHELINE SYENITES OF WEST AFRICA.—The region of Christiania, described in a classic memoir by Brögger, and noted for its richness in rare minerals associated with alkaline igneous rocks, has a rival in the Archipelago of Los, situated close to the shore of French Guinea on the West Coast of Africa. The islands, three in number, consist of masses of nepheline syenite with their usual satellitic associates—tinguaites, essexites, theralites, shonkinites, camptonites, and monchiquites. These are fully described by Lacroix in a finely illustrated memoir, "Les Syenites Nepheliniques de l'Archipel de Los et leur Mineraux" (*Nouv. Arch. d. Mus. Paris* (5) iii, 1911). In addition to a rich series of rare minerals, such as astrophyllite, rinkite, wöhlerite, eudialyte, catapleiite, and pyrochlore, usually found associated with nepheline syenite, Lacroix describes two new minerals, *villiaumite* (sodium fluoride), of a violet [illegible] red tint, supposed tetragonal symmetry, and soluble in water; *losite*, a mineral allied to cancrinite, but differing from it in several particulars, notably in lesser birefringence.

As no associated strata are known, nothing can yet be determined as to the geological age of this [illegible] series. On the adjacent mainland of French Guinea there occurs a totally different series of rocks, consisting of hypersthene granite (charnockite), norite, gabbro, and peridotite, a series which has much in common with the charnockite rocks of India.

CRYSTALLIZED TURQUOISE. Hitherto the turquoise has never been found in distinct crystals. It has always been opaque and massive, usually of a green colour, only the best qualities shewing the well-known blue. It is found in irregular masses filling up cavities and fissures in the mother rock. An occurrence from Virginia (Schaller, *Amer. Journ. Science*, January, 1912), however, seems to show that turquoise may sometimes assume a definite crystallized form. The specimen consists of irregular fragments of glassy quartz cemented by thin layers of turquoise crystals. On each side of the specimen is a drusy, botryoidal layer, bristling with minute crystals of a bright blue colour. Their density is 2·84, and whilst their smallness rendered their crystallographic determination difficult, it is believed that they have triclinic symmetry and are isomorphous with chalcosiderite. A chemical analysis gives the following result:—

P_2O_5 ...	34·13
Al_2O_3 ...	36·50
Fe_2O_3 ...	·21
CuO ...	9·00
H_2O ...	20·12
	99·96

The formula derived from the ratios of the analysis is CuO, 3 Al_2O_3, 2 P_2O_5, 9 H_2O. The above analysis agrees very closely with one by Penfield on very pure massive material from Nevada. The correct formula for chalcosiderite is similar to the above, with the substitution of iron for aluminium. Moreover, its crystal angles are very close to those tentatively given for the minute crystals of turquoise. Consequently there is a strong probability that the two minerals are isomorphous.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended January 20th, as set out in the statistical tables issued by the Meteorological Office in the Weekly Weather Report, was wet and unsettled. Snow or sleet was general during the earlier days of the week, and the falls were heavy except in the Southern parts of the country. Temperature was above the average in Scotland, N., the southern parts of England and in Ireland, but below it elsewhere. The variations, however, were nowhere very large. The highest of the maxima was 57° at Fort Augustus, on the 17th. In Jersey the highest reading was 52°. Readings of 50° or upwards were reported in all districts except England, N.E. and E., and Scotland, W. The lowest reading reported was 18° at Balmoral on the 20th, but temperatures down to 22° were recorded at several other stations. In Ireland, however, the temperature did not fall below the freezing-point, and in the English Channel the minimum was 35°. The lowest reading on the grass was 15° at Balmoral.

Rainfall was in excess of the average in all districts except Scotland, N. and Ireland, N. The wettest district, relatively, was the Midland Counties, where the recorded fall was nearly four times as much as usual. At Birmingham the total fall was more than five times the average, 2·22 ins., as compared with the average of 0·44 in. Sunshine was in defect in all districts, and at every individual station except two, Markree Castle and Scilly. The last-named station was the sunniest in the British Islands with a mean daily duration of 2·0 hours or 24%. At Westminster [illegible] temperature [illegible] 37° at Scarborough [illegible] S. and Scilly.

The week ended January 27th was dull [illegible] southern districts [illegible] mist or fog at [illegible].

Temperature was [illegible] the English Channel [illegible] parts the deficiency considerable. The highest readings of the week [illegible] Bettws-y-coed and [illegible] at Killarney. In the English Channel the maximum was 5[illegible]°, but in most of the districts the maxima failed to reach 50°. The lowest readings were 18° at Balmoral and 21° at Poltalloch. In the English Channel the minimum was 30°, but in every other district sharp frost was reported. On the grass the lowest readings recorded were 15° at B[illegible] and Hillington, and 17° at Newton Rigg, Llangammarch and Markree.

Rainfall was above the average in England, N.E., E., and S.E., the Midlands and the English Channel, but was in defect elsewhere. The defect in many cases was extreme, and at some stations the week was rainless. In Ireland, N. the mean for the week was only 0·01 inch as compared with an average of 0·81 in., and in Scotland, N. the mean was 0·11 in., the average being 1·63 inches.

Sunshine as a rule was in excess in those districts where rainfall was in defect. The sunniest district was Ireland, S., with a mean daily amount of 2·3 hours (28%). Scotland, N., with a mean of 1·8 hours, was 12% in excess of the average, while the English Channel, with a daily mean of 1·9 hours, was 8% below. At Westminster, the daily mean was only 0·2 hours (2%). The mean temperature of the sea water ranged from 40°·0 at Burnmouth and Cromarty to 48°·4 at Scilly.

The week ended February 3rd was very cold, but dry and sunny. Temperature was below the average in all parts, the deficiency amounting to as much as 10°·1 in the Midland Counties, and to 9°·7 in England, S.W. The highest of the maxima was 49° at Waterford, but at many of the stations in the Midlands and England, E., the maximum for the week was under 40°. In the English Channel 47° was the highest reading recorded, at Guernsey, on January 30th. The minima were 15° or below in every district except the English Channel where the lowest reading was 28°. The lowest readings were 4° at Balmoral on the 2nd, 9° at Llangammarch and 10° at Fort Augustus. On the grass readings down to zero were recorded at Norwich, Balmoral and at Burnley.

Raintall was light very generally, and was below the average in all districts. Indeed, over a large part of the country the week was practically rainless; thus, in England, S.W. the mean total for the district was 0·01 inch, the average being 0·82 inch. Bright sunshine, on the other hand, was above the normal everywhere, the excess reaching 30% in the English Channel, where the mean daily duration was 5·2 hours or 57% of its possible duration. The advantage of the suburbs as regards duration of sunshine is strikingly illustrated by the figures for this week, the mean daily duration being at Westminster 0·5 hours (6%); at Camden Square 2·6 hours (29%), but at Hampstead 3·7 hours (42%).

The mean temperature of the sea water varied from 37°·9 at Scarborough to 47°·8 at Plymouth.

The week ended February 10th was at first very cold, with snow showers in nearly all parts. After Monday, however, a thaw extended over the country from the southward, the air became humid, and rain was frequently experienced. Temperature for the week was below the average in all districts except the English Channel, where it was very slightly above. Maxima above 50° were reported from all districts, the highest readings being 56° at Bath, Clifton and Llandudno. The lowest readings were on the Sunday or Monday, and were below 17° in all districts except the English Channel, where the minimum was 27°. The lowest reading reported was −5° at West Linton, on the 4th, or 37° below freezing-point. At Balmoral a reading of −2° was recorded on the 5th, and at Gordon Castle the minimum was 1° on the 4th. On the grass a reading of −7° was recorded at Crathes.

Rainfall, though but little more than one-third the average amount in Scotland, N., was in excess in Scotland [illegible] and in [illegible] deficit; it was generally in excess, [illegible] the mean were inconsiderable. Sunshine [illegible] in excess in Scotland, N., and [illegible] England, N.W. [illegible] a deficit elsewhere. In Scotland, W., the daily [illegible] hour [illegible]. The [illegible] station was Great Yarmouth, where the daily mean was [illegible] hours. At Westminster the duration averaged 0·9 hours [illegible] in contrast with the previous week the [illegible] was [illegible] hours [illegible]. The mean temperature of the sea water [illegible] from 36·2 at Cromarty to 45·8 at [illegible].

MICROSCOPY.

conducted with the assistance of the following microscopists :—

[illegible] Arthur Earland, F.R.M.S.
[illegible] Richard T. Lewis, F.R.M.S.
[illegible] Chas. F. Rousselet, F.R.M.S.
[illegible] D. J. Scourfield, F.R.M.S.
C. D. Soar, F.L.S., F.R.M.S.

LOW POWER PHOTO-MICROGRAPHY WITHOUT A MICROSCOPE.

This note is chiefly concerned with home-made contrivances of a very simple character, designed to be of service in simple low power photomicrography. By this latter term is meant that region of work between the ordinary "copying" of everyday photography, and the more ambitious augmentations which necessitate the use of a microscope as well as a camera. In this chapter a microscope is not used, but contrivances are shown which enable us to use ordinary micro-objectives of low power, *i.e.*, an inch or so. When lenses of focal length not less than two inches (say two to four inches range) are to be employed with any ordinary quarter-plate camera of, say, twelve inch bellows length, it is clear that we cannot get any very great magnification or ratio of image to object. It will, therefore, be desirable to augment the camera length by some means. The convenient plan is by the use of a metal tube, one end of which screws into the ordinary camera lens flange, the other end cut with a similar thread to take the lens to be employed. It is a further convenience to have this tube in two pieces AB and CD, as shown in Figure 109, so that we may use one or both pieces according to our desired degree of magnification.

The end A screws into the flange on the camera front. B and C join up together. D is here closed by an "adapter" to take any ordinary micro-objective. E is a two-inch Zeiss protar with lens cap F. The size of this particular tube is large enough to take a Wray four-inch R.R. or Wray three-inch platystigmat, both exceedingly useful tools for natural history work, e.g., insects, fossils, shells, parts of plants, and so on. Lenses of these kinds are already provided with stops or diaphragms, but when the worker is using ordinary long focus (e.g., two-inch) micro-objectives, it is often of very great service to use also a contrivance known as a Davis shutter. This is shown in Figures 110 and 111, where we see the two sides of the micro-objective adapter that was similarly lettered in Figure 109, and also two views of the "Davis" which is really a separable iris diaphragm contrivance. As this cannot be put inside the lens it is screwed into the adapter, *i.e.*, between D and the objective in use. The worker will find it very convenient to cut a card wedge showing points of width one-, two-, three-, and so on, tenths of an inch. This wedge is inserted into the iris which is then closed just to grip it and the pointer outside correspondingly marked one-, two-, three-, and so on. We can thus at any time close down the "pupil" to any required size by means of the pointer and scale. It should be remembered that the exposure normally will vary as the squares of these numbers. Thus, two-tenths diameter passes four times, and three-tenths nine times, as much light as the one-tenth diameter opening. A glance at the table will make matters clear in a moment. Suppose the largest aperture is half an inch, *i.e.*, five-tenths.

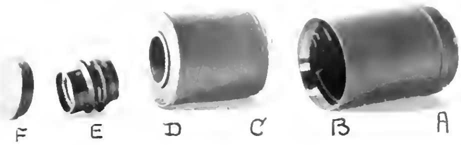


Figure 109.

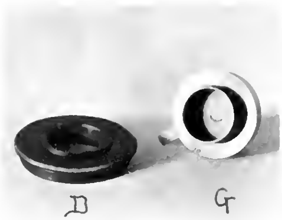


Figure 110.

Figure 111.

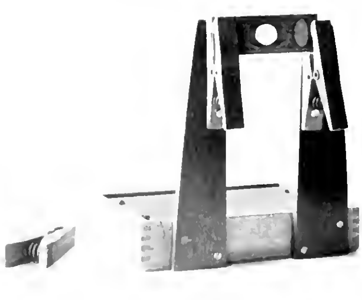


Figure 112.

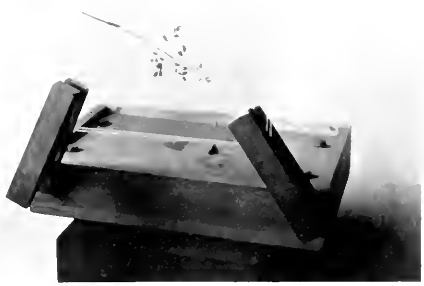


Figure 113.

Numbers on [illegible] 10th of inch [illegible]	1	[illegible]	[illegible]	4	5
Area of openings	[illegible]	4	[illegible]	[illegible]	25
Exposure ratio approximately	25	[illegible]	[illegible]	[illegible]	1

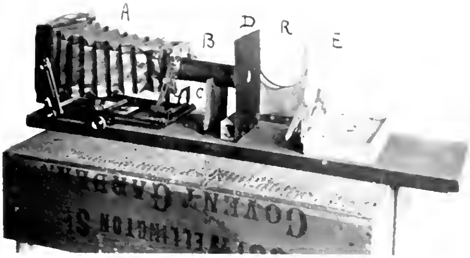


FIGURE 114.

Holders. The nature of the object holder will necessarily vary with the nature and size of the object. I give two very generally useful forms. Figure 112 shows us a small rather heavy box to which are fixed two thin flat pieces of wood (e.g., bits of cigar box lid). To these, in turn, are screwed two ordinary wood spring (American) clothes clips, which one may get by the dozen for a few pence at any "oil shop." This contrivance enables us to hold any ordinary microscopic slide, as shown in Figure 112.

Figure 113 is a similar heavy box used as a base; to this a pair of spring clips are fixed. These, in turn, grasp a pair of clean thin glass plates between which it is often convenient to "sandwich" such a thing as the flowering part of *Poa annua*, and so on.

Passing now to photographic arrangements, we have in Figure 114 one of the simplest contrivances imaginable, *viz.*, a flat, straight, thick, heavy piece of wood, which serves as a baseboard on which rests A, an ordinary camera, with extension lens tube B, which requires a support C (shown in a subsequent figure, F. 120). The object sandwiched between two pieces of plain glass is held at E (in the contrivances shown in Figure 113). At R is a small circular mirror fitted up for use as a reflector, also shown in other figures.

Some such simple contrivance as this may serve the careful and patient worker for occasional use, but it will be found that there is considerable risk of getting the parts out of position unless we have some ready means of fixing them to the baseboard. In connection with the plan of using a glass sandwich arrangement, Figures 113 and 114, it should be noted that there is in certain lightings a considerable risk of getting harmful reflections. To obviate this the following plan is efficient. To a piece of stout card (e.g., straw board) fix a piece of rough black cloth by means of paste or glue. This card may be about eight by six inches. When the paste is dry, cut a circular hole the exact size of the glass part of the lens, and in such a position that when the card rests on the baseboard this hole just coincides in position with the lens opening.

S[illegible] position [illegible] the [illegible].

I now [illegible] board. [illegible] of a piece [illegible] four feet long, two [illegible] inches wide and [illegible]. This is firmly fixed to [illegible] ordinary [illegible] A. Figure 116 [illegible] its central hole [illegible] top, but its [illegible] the wood of the [illegible]. The camera is fixed to the baseboard by a [illegible] screw, B. The object [illegible] holder, D, to be presently described, while E is a [illegible] reflector. At C [illegible] piece of card covered with black cloth. This is used for making the exposure. It is here shown to be leaning up against the object, [illegible] this card is combined with the Davis diaphragm. The advantages of this system are portability, *i.e.*, we can move the whole thing about together so as to get the object in a favourable lighting, and it is remarkably free from the effects of vibration, any disturbance of the floor causing the whole contrivance to vibrate as one thing.

Next a word as to the object holder. The general arrangement will be made sufficiently clear by a glance at Figures 115 and 117. The former shows that this apparatus is made to slide along, and yet grip the baseboard along its edges. Figure 117 shows how the two holding springs are fashioned out of pieces of an ordinary steel knitting needle. This is made red hot in a gas flame and then gently bent to the shape shown by the aid of a couple of pairs of pliers. When piercing the sight hole in the holder (Figure 115) it is important that its centre is just opposite the centre of the lens extension tube. This will be found of help when getting the object slip into position, and also in setting the axis of the camera parallel to the baseboard.

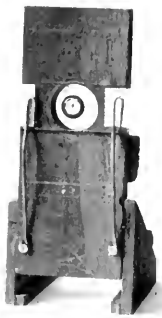


FIGURE 115.

In Figure 118 we see a back view of the mirror and its mount. The mirror is about four inches in diameter, and has a thin metal rim frame. A semi-circular hole is cut out of the thin flat piece of wood A and the mirror swung by two screws C, C just tight enough to hold it at any desired angle. At B a small block of wood is added to give weight and firmness and prevent the whole thing being top-heavy.

In Figure 119 we see the front side of the mirror holder and should note carefully a small circular peg or dowel in the front edge of the holder. This engages with an easy fitting hole in the baseboard and enables the holder to be turned about a vertical axis through this dowel or peg, while the two side screws C, C give us a horizontal axis; thus we can set the mirror at any angle by combining these two movements.

I now come to the last bit of home-made

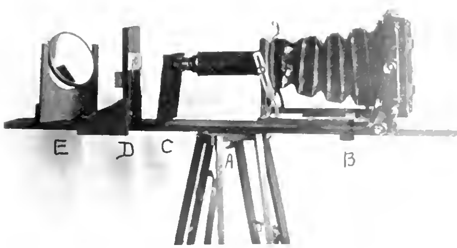


FIGURE [illegible].

[illegible] so that my pair [illegible] when [illegible] and [illegible] M A and B [illegible] have the subject [illegible] [illegible] A [illegible] itself [illegible] focus [illegible] three inch [illegible] It is [illegible] posed to [illegible] two of the lens [illegible] by [illegible] of brown paper tube D. [illegible] lens B [illegible] but smaller than [illegible] A. lens B had to have its diameter brought up to match that of A by means of an extra bit of tube, C. These card tubes are easily made of brown paper strips and office paste, using the lens tube as a roller, but remembering that the paste wetted paper will contract a trifle, the lens tube should be covered with two laps of thick, smooth writing paper. Without this you may find your tube too tight when it is dry. Taking the diaphragm distance as the nominal "separation," we can apply the usual rule for finding the combined focal length of the four and three inch components. First multiply four by three, getting twelve. Now add four to three, getting seven, and substracting the diaphragm distance or "separation," say one inch, we get six. Finally, dividing twelve by six we get two inches as the focal length of the whole system. As a matter of fact, this estimate was shown to be practically right, but the smallness of the stops of one of the lenses gave an inconveniently restricted field. However, the idea is worth mentioning.

Finally, Figure 121 shows this combination in use. Note the card support E, Figure 120, to take the front weight of the tube. We here get a side view of the object holder which, when combined with the front view of Figure 115, will enable this item to be easily made. The exposing black card S is shown, and also the reflector with its dowel-peg (cf. Figure 119) inserted in the baseboard. E. C. LAMBERT, M.A., F.R.P.S.

FIGURE 117.

FIGURE 118.

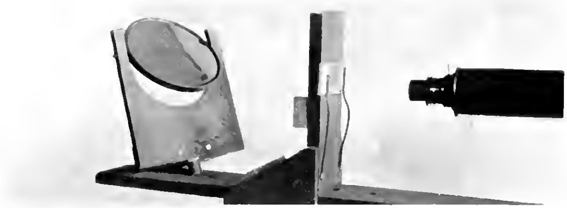


FIGURE 119.

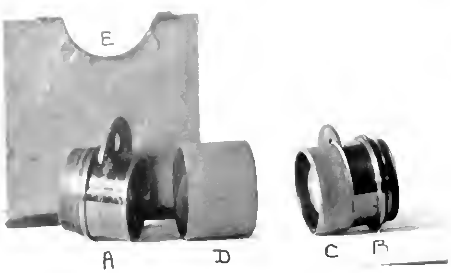


FIGURE 120.

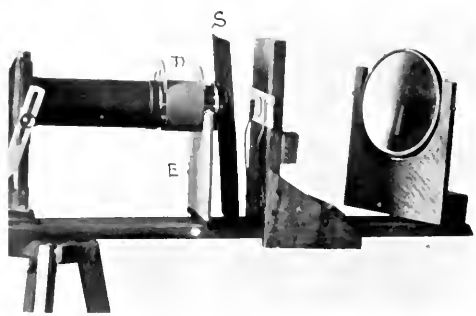


FIGURE 121.

ROYAL MICROSCOPICAL SOCIETY.

February 21st, 1912.

H. G. Plimmer, Esq., F.R.S., president, in the chair. Mr. E. J. Spitta, with the help of the projection Lantern, demonstrated the principles which should influence the photographer in the preparation of negatives from which coloured lantern slides were subsequently to be made. Commencing with photographs of the spectrum taken upon the various sensitised emulsions at present on the market, he pointed out the necessity for the use of panchromatic plates. He showed a number of slides, macroscopical as well as microscopical, by means of which he contrasted the effects produced by colouring lantern slides made from ordinary plates with those prepared from panchromatic plates, and showed the wide possibilities which were opened up to the skilful artist.

Mr. Rousselet communicated the "Fourth List of New Rotifera since 1889" (*i.e.*, the date when Hudson and Gosse's Monograph of the Rotifera was completed by the issue of the supplement, recording altogether four hundred species at that time). The author explained that his three preceding lists, published in 1893, 1897, and 1902, contained three hundred and ninety-three new species, and the fourth list now submitted two hundred and fourteen names, a total of six hundred and seven new species since 1889. After making allowances for synonyms and insufficiently recorded species, Mr. Rousselet estimated the present Rotiferous population of the world comprised eight hundred and fifty-seven species. A slide of *Navicula socialis*, presented by Professor T. Chalkley Palmer, was exhibited by the Society. This is a fresh water diatom, discovered by the donor in 1905 near Media, Pa.

A UNIVERSAL GEOMETRIC SLIDE PHOTO-MICROGRAPHIC APPARATUS.—We are glad to give in Figure 122 an illustration of a carefully designed piece of apparatus which Mr. J. E. Barnard described before the Royal Microscopical Society last November, and which he has now put on the market through Mr. Charles Baker. Extreme rigidity is obtained, and it can be used with a vertical as well as an horizontal camera and with almost any type of microscope, whether it has a horseshoe or a tripod foot. All the pieces of apparatus carried on the geometric slide are mounted so that they can be centred accurately to the optic axis of the instrument, and may be clamped down when once their position has been determined.

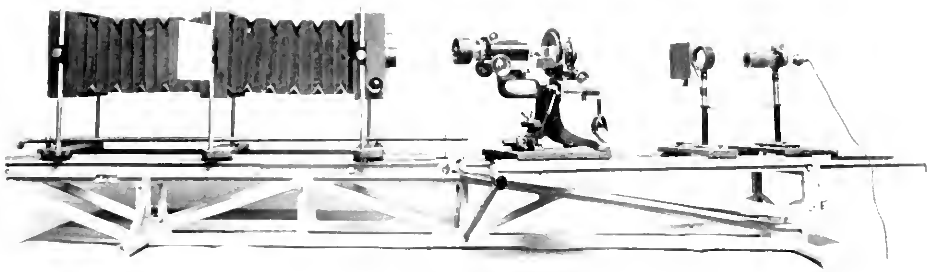


Figure 122.

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

ANOTHER NEW BRITISH BIRD—THE COLLARED FLYCATCHER.—The addition of this species (*Muscicapa collaris* Bechst.), to the British list falls to be chronicled this month, two male birds having been shot in Udimore Lane, near Winchelsea, on 12th and 13th May, 1911, respectively. This bird is similar in appearance to its near relative the Pied Flycatcher, but has a conspicuous white collar, well shown in the photograph given in *British Birds* for February 1912 (Vol. V, page 238), from which the above particulars are taken. Its summer range is in south-east Europe generally, and it is very local elsewhere on the Continent. On passage it is known in most parts of Europe, Persia, Asia Minor and Palestine. It winters in Egypt.

HYBRID GREENFINCH AND CHAFFINCH.—At the cage-bird show of the London and Provincial Ornithological Society held at the Crystal Palace, London this month (February), much interest was aroused by a hybrid bird between a Greenfinch and a Chaffinch. Such a cross is stated never to have been known before, and the particular bird shown is described as small and slenderly built with brownish plumage, tinted delicate green in certain lights. In captivity, the Greenfinch will inter-breed with the Canary, and in a wild state with the Common Linnet.

THE LAST OF THE PASSENGER-PIGEON.—There now seems to be only a solitary bird (a female, about nineteen years old, belonging to the Zoological Society of Cincinnati) alive to represent the famous Passenger or Wild Pigeon (*Ectopistes migratorius*), which, within the memory of living man, bred in enormous numbers all over the forests of North America. Wilson, the American ornithologist, estimated that a flock seen by him consisted of more than two thousand two hundred and thirty millions of birds, and Professor Newton, in repeating this, says that the bird is "still occasionally to be found plentifully in some parts of Canada and the United States" (*Dictionary of Birds*, 1893-1896, page 696). Now, within twenty years, it has fallen to the very verge of extinction, and the great researches, recently made to find survivors in a wild state, have been quite unsuccessful. It seems likely that the Passenger Pigeon will soon rank with the Great Auk as an historical species only. The last living examples in the Zoological Gardens, London, were presented in 1883, one of which survived till 1889. In the Natural History Museum, South Kensington, there are twenty-one specimens of this Pigeon. The species is on the British list as a "doubtful" one, the five examples on record being looked on as introductions, although Professor Newton says that one shot in Fife in 1825 may have crossed the Atlantic unassisted by man (*Loc. cit.* page 697).

THE FATE OF THE CAROLINA PARAKEET.—This bird (*Conurus carolinensis*) seems destined to pass away in like manner to the Passenger Pigeon. In North America at the beginning of last century it ranged in summer as far north as the shores of Lakes Erie and Ontario, but before the end of the century its limits were curtailed to the Gulf States. At the present date, except for some eleven individual birds in captivity in the United States, it has completely disappeared. In Europe, about thirty years ago, it was freely kept as a cage-bird, but it is improbable that there is now a living example on the Continent. The last specimen in the Zoological Gardens, London, died in 1902 and the last in the Berlin Gardens in 1904.

HIBERNATION AMONG BIRDS.—A reviewer in the current number of "Knowledge" (February, page 70), speaks of the theory of the hibernation of swallows as "long exploded." That it still exists in a nebulous way, and is considered worthy of investigation in well-informed quarters, may be seen by the statements made recently by Mr. C. W. Nash, biologist to the Ontario Government. He writes: "I have found evidence (of a sort) which leads me to believe that the Purple Martin and Chimney Swift may at times become partially dormant, and I have received recently from an eye-witness an account of the cutting down of a hollow tree near Peterborough (Canada) in the month of January many years ago. This tree is said to have contained hundreds of swallows in a dormant state, some of which were revived. I have the names of other witnesses of this curious incident, and am looking them up." This cannot be called conclusive evidence, but the result of the enquiries to be made will be awaited with curiosity. It may only be a coincidence and not in any way to be looked on as a corroboration, but the winter quarters of the Canadian Chimney Swift, one of the birds named, are not known. Such a fact shows how deficient we still are in complete knowledge of the localities and regular movements of even common birds, whilst, as regards the causes and reasons of migration, many of the theories and conjectures put forward seem to be as inadequately supported by proof as is the theory of hibernation.

A CONVEYED PEREGRINE.—On the morning of 29th December last a Peregrine was found flying round one of the rooms in the General Post Office, Glasgow, but this puzzling occurrence has been nicely explained by Mr. John Paterson. He writes:—"When the S.S. *Anchoria* of the Anchor Line, on her maiden trip to Calcutta, had been in the Red Sea a couple of days, a hawk was seen on the top of one of the masts getting an assisted passage on its southward journey in the wake of the migrating flocks from the north, on whom it naturally preys." The bird was secured by a sailor; and in a box, fitted as a cage, "made the journey to Calcutta and Glasgow, by way of some Italian ports." It was presented by the captain of the steamer to Mr. Paterson, in Glasgow, who was curious to exactly know what kind it was. He found it to be a "young peregrine falcon . . . . or passage-hawk, the name falconers gave to a young bird caught during the season of migration." Having satisfied himself, Mr. Paterson thought to give the bird freedom and accordingly let it off within the city of Glasgow. Such freedom as the atmosphere of Glasgow may afford to a falcon was apparently not congenial, and the following morning found the bird in the toils again, as above mentioned. The case is a good illustration of how "casual" introductions may be made into our fauna, by man's agency.

WADING BIRDS INLAND ON MIGRATION.—In East Renfrewshire a group of small upland reservoirs, of which Balgray Dam is the largest, has been long known to Clyde bird-men as a resort of waders and other water-birds. Mr. John Robertson, who has paid particular attention to the locality, reports that the autumn of 1911 was the best season there for waders in his experience of sixteen years. The shortage in summer rainfall led to the exposure of so great an area of the bottom of Balgray Dam that passing birds were attracted to it as a feeding ground in greater numbers than usual. Mr. Robertson considers these birds to be making their way from the Forth to the Clyde; that is to say that these dams are a point on a line of migration-flight across Scotland. The spot is not particularly favoured in natural situation and surroundings, being on the edge of the extensive industrial area of the lower Clyde valley, and almost in touch with suburban Glasgow, but no fewer than twenty-two species of waders have been noted there. Of these Mr. Robertson observed seventeen last autumn, from August to October. The movement began with the appearance of Ringed and Golden Plovers on 30th July, and the most noteworthy birds seen were the Turnstone, Curlew-Sandpiper (up to 20 in numbers), Knot (up to 24), Ruff, Green Sandpiper, Greenshank, and Bar-tailed and Black-tailed Godwits. In previous years the Grey Plover, Little Stint and Spotted Redshank had been seen. (John Robertson—*The Glasgow Naturalist*, November, 1911, volume IV, pages 7-10. Glasgow: John Smith & Son, Ltd.) Of the above-named, it may be remarked that it is quite exceptional to find the Turnstone, Knot, and the two Godwits inland in Scotland.

PHOTOGRAPHY.

By Edgar Senior.

PHOTOGRAPHING THE INVISIBLE.—Mysterious as the above title may appear, it has no connection with ghosts or spirit photography, but is merely intended to infer that, as far as the eye could discern, no light whatever reached the photographic plate. Such, however, were the conditions present, that plenty of rays which our eyes had no cognizance of, were able to do so and act photographically upon it. As far back as 1801, Ritter, of Jena, proved the existence of rays having very powerful photographic properties occupying a region beyond the extreme violet end of the spectrum, which do not excite the organs of vision, and to which the name ultra-violet is given. To Sir George Stokes we owe the discovery of how to make this region apparent. The beautiful experiment consists in placing a card, which has been coated with quinine sulphate made slightly acid, in their path, when rays which were previously invisible at once shine forth, and the extent of the spectrum beyond the violet becomes apparent. That these ultra violet rays have powerful chemically active properties is well known, their behaviour towards silver chloride being of special interest. If a piece of fused silver chloride be placed in front of the slit of a spectroscope, the light that passes through forms a spectrum apparently unaltered in range from the ordinary one, but if a card coated with a solution of quinine sulphate be placed in position beyond the violet no effect is produced, the invisible rays appear entirely absent; but the removal of the slab of silver chloride at once makes them appear, and from this we gather that the silver salt has absorbed them, and that chemical action will consequently take place in this region. In fact, the violet and ultra-violet rays are the most active upon silver salts generally, as well as those of iron, uranium, chromium, and so on, and to such an extent is this the case, that formerly the violet end of the spectrum was regarded as the seat of chemical energy, and the name actinic rays applied to that region. This, however, can no longer be the case, as all parts of the spectrum are actinic, according to the nature of the sensitive compound employed. The idea of taking advantage of the sensitiveness of silver salts to these rays of short wavelength, and so obtaining photographs of things invisible to our eyes is almost as old as photography itself, for we find the suggestion of the experiment outlined in the "Pencil of Nature," published by Fox Talbot in 1844. After describing the production of a solar spectrum and the effect produced upon a sheet of sensitive paper by the rays beyond the violet "whose existence is only made known by the chemical action they exert," he suggests the possibility of separating them from the rest by passing them through an aperture into an apartment, or room, and so filling it with invisible rays, when, if a camera were so placed as to point in the direction of any objects, photographs might be taken by means of the action of the invisible radiations upon the sensitive plate. Talbot thus believed that it would be possible for a person seated in a totally dark room to have a portrait taken in the ordinary manner, or, in other words, that we should be able to photograph the invisible. The very fascination of the subject induced the writer, "some years ago now," to experiment in the direction indicated, with the result that among those photographs produced in this way that of greatest interest "from its close connection with the ideas of Talbot," is the one that is reproduced above to form Figure 123. Although not carried out in quite the same manner as that suggested, the principle remains the same, as only those dark rays which exist beyond the violet were utilized, all visible light being cut off by means of a screen devised by Professor R. W. Wood combining a piece of cobalt blue glass

FIGURE 123.

A Portrait taken with Ultra-Violet Rays.

with a film dyed with a solution of Nitrosodimethylaniline, $C_6H_4\left\langle\begin{matrix}NO\\N(CH_3)_2\end{matrix}\right.$ which allows only ultra-violet rays to pass through. To illuminate the sitter, an arc light was employed and the exposure with a rapid plate was five minutes. The sharpness of the image is not all that might be desired, but this is no doubt due to the difficulty of ascertaining the correct focus, together with the want of correction of the lens (a portrait one) for these rays. Considering that the lens and screen employed were composed of glass, the results obtained are remarkable, as this material is very opaque to ultra-violet rays; so that, as suggested by Professor Wood, quartz, which is exceedingly transparent to these invisible rays, should be employed instead, and lenses made of this material on the surface of which a thin film of metallic silver has been chemically deposited to such an extent that there is complete opacity to visible light and only those rays between three thousand and three thousand two hundred transmitted. A great peculiarity about photographs taken in ultra-violet light is the absence of strong shadows, and the rendering of some white flowers almost black. Again, their action in causing fluorescence and phosphorescence are well known, and in all probability in extremely short wavelengths they constituted X-rays. Two French savants are also credited with the discovery that all explosives are very unstable in ultra-violet light. Ultra-violet light is also made use of in the sterilisation of water, a mercury vapour lamp enclosed in a quartz chamber being employed for the purpose. Further examples might be taken showing the action of these rays, until we might almost feel inclined to use the phrase "Ultra violet light magic!" in all seriousness.

EXPOSURE TABLE FOR MARCH.—The calculations are made with the actinograph for plates of speed 200 H and D, the subject a near one, and lens aperture F16.

Day of the Month	Condition of the Light	Time of Day: 11 a.m. to 1 p.m.	10 and 2	3 p.m.	Remarks
Mar. 1st	Bright	15 sec	2 sec	25 sec	If the subject be a general open landscape take half the exposures given here
" "	Dull	3 "	4 "	51 "	
Mar. 15th	Bright	13 sec	15 sec	2 sec	
" "	Dull	26 "	3 "	4 "	
Mar. 30th	Bright	1 sec	12 sec	16 sec	
" "	Dull	2 "	24 "	3 "	

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

A NOTE ON FLUORESCENCE.—A large number of substances when they absorb light give out light of different wavelength. Thus, if a piece of uranium nitrate be held in a beam of ultra-violet invisible light, it will become visible and give out wavelengths ranging through the green portion of the spectrum. If a little fluorescein is shaken on the surface of a jar of water, the fluorescein as it dissolves gives beautiful streaks of green in the liquid, though when the solution is mixed up it transmits an orange light. Light passing through the liquid has certain wavelengths absorbed from it, and the energy thus absorbed goes partly to set the electrons within the fluorescein molecule vibrating and give out light of their own particular period—a vivid green light. Kaempf has recently passed light through a solution of fluorescein, both when it is rendered fluorescent by light from another source and when it is not, and the intensities of the transmitted light are then compared. No change in the intensity of the transmitted light is caused by the fluorescence set up by the other light source. Every absorbable wave has its energy subtracted from the incident beam of light and the absorption is independent of the intensity of the incident light.

Many substances fluoresce, examples giving very beautiful effects are eosin, magdala red, rhodamine, aesculine, quinine. It is probable that the list of fluorescent substances is very large; only the emitted light is in the infra-red and invisible region of the spectrum.

POSITIVE IONS FROM METALS.—When metals are heated *in vacuo*, positive ions are given off. It is not yet certain whether the ions are due to adsorbed gases or to traces of impurities or to chemical reactions with the metal, residual gases and glass, and the like, to which the metal is attached. The adsorbed gases, according to recent work of Klemensiewicz, appear to cause most of the effect; but Professor Richardson has shown that the marked positive ionisation effect obtained with aluminium phosphate is chiefly due to the presence of sodium salts.

GRAVITATIONAL FORCE.—The accurate measurement of the force of gravity, which varies at different parts of the surface of the earth, is a matter of some difficulty. The counting of the number of swings that a pendulum of known length will make in a known time is the principle on which all accurate methods rest. The pendulum is hung from a rigid support in an air tight case from which the air is partially exhausted, and with the aid of chronometer and electric flash apparatus the time of half-swing of the pendulum is observed. The support of the pendulum must either be quite rigid, which is practically impossible to attain, or its movement must be known. The support should be mounted on a concrete pier extending six-feet into the ground, and its motion determined by means of an optical instrument detecting very slight movement, called an interferometer. The measurement of gravity at sea can only be accomplished by a comparison of the height of the mercury barometer and of the pressure calculated from the temperature at which water boils. Where the force of gravity is greater, the height of the mercury column will be slightly less than the height calculated from the boiling-point.

EMISSION OF ELECTRICITY FROM HEATED CARBON.—Drs. Harker and Kaye have found that if two insulated carbon electrodes are placed in a high temperature furnace, and one of the carbon poles is cooled, that a current is set up between the two through an ammeter connected to them. By cooling one of the electrodes a permanent current is maintained of 0·8 ampère nearly. The currents are presumably due to discharge of negative electrons from the hotter electrode, a current being thus able, through the ionisation of the gas in the furnace, to pass from one electrode to the other. This effect appears to lend support to the ideas held about the action of an oscillatory Dudell arc.

PHOTOELECTRIC FATIGUE.—Experiments made by H. S. Allen and by J. Robinson on the fatigue shown by various metals in the production of negative ions by the stimulus of ultra-violet light, are somewhat at variance. Robinson's results show that such fatigue exists. Ultra-violet light passes through a window of quartz, and falls on a polished plate of zinc. It then charges itself with positive electricity if insulated. The potential can be measured by an electrometer. The rate of charging is diminished when the plate is exposed to ultra-violet light at zero potential at the commencement; but if the plate is "fresh," *i.e.*, kept in the dark for some time previous to exposure, the rate of charge is much greater. Hallwach's theory of the cause of photoelectric fatigue is that when electrons leave the surface of a metal, the stream will draw up out of the metal occluded gas molecules, which will accumulate at the surface and prevent the electrons getting through, since these slow-moving electrons are easily absorbed by gases. If the plate is charged positively no electrons leave the surface, and there will be no accumulation of gas there, and therefore no fatigue. Recovery from fatigue is supposed to be due to the gas becoming more uniformly distributed within the metal. Experiments were also carried out with aluminium.

AFTERGLOW OF ELECTRIC DISCHARGE.—Professor Strutt has recently given an account to the Physical Society of the continuation of his work on the [illegible] found that [illegible] Strutt [illegible] not made [illegible] the glow by [illegible] presence of [illegible] Professor Strutt finds, however, that the [illegible] the low concentration of ozone produced by [illegible] for on condensing out the ozone as a blue liquid [illegible] and then letting it vaporise into a vacuum, and treating it with a small quantity of nitric oxide, the [illegible] at once produced. He thus shows that the discharge in rarefied air produces a very considerable percentage of ozone. The intermittent discharge passed through air at ordinary pressure and especially at slightly reduced pressure gives a yellow flame with a sharp apex considerably above the curved path of the electric current through the air. This flame is the glow produced by the combination of nitric oxide and ozone. Oxygen itself gives a glow of a pale whitish aspect. It has been long a question whether this is due to impurity or not. Professor Strutt was able to demonstrate that the glow is due to water vapour as an impurity in very small quantity. If a wire connected to a Leyden jar be coiled round a glass bulb containing rarefied pure oxygen, the afterglow can be produced by the electrodeless ring discharge; but if a fine tube connected to the bulb be immersed in liquid air, the water vapour is condensed out and the afterglow is extinguished. The electrodeless ring discharge has been recently investigated in the Cavendish Laboratory at Cambridge. It has been found to be useful in distinguishing the presence of gases in small quantities as impurities in another gas, the masking effect of one spectrum on another being less apparent in the case of the electrodeless discharge. Various spectra are obtained under different pressures, and different intensities of discharge, these being peculiarly evident in the case of argon, which gives either a red or blue glow under the different circumstances. (See Donaldson, *Phil. Mag.*, October, 1911.)

ZOOLOGY.

By Professor J. Arthur Thomson, M.A.

WHALES' HAIRS.—Although hairs are reduced to a minimum in Cetaceans, there is probably no species entirely without them. Dr. Arnold Japha has recently studied five baleen whales and six toothed whales, and has found hairs about the lips of them all. Apart from their great reduction in number, they show distinct signs of retrogression. The hair muscles and glands have gone, the hair shaft is greatly reduced, the root sheath is simpler than usual, and there is no hair casting. On the other hand, there is very interesting specialisation, notably in the rich supply of nerve fibres and in the way these end in the hair-follicle. There may be four hundred nerve fibres to one hair, so that if there are twenty-five hairs on the chin there are ten thousand nerve fibres on a small area. In the toothless Cetaceans at least it seems highly probable that these sensitive hairs play a rôle of some importance in food-getting.

REPRODUCTION OF BROWN RATS.—The economic and medical importance of the brown rat makes it particularly desirable that we should know as much about it as possible. Newton Miller has furnished some precise data as to the details of reproduction, based on the study of rats in captivity. The creature breeds all the year round. The young are carried from twenty-three and a half to twenty-five and a half days before birth. The number in a litter varies from six to nineteen, with an average between ten and eleven. Five or six litters may be actually reared by a single pair in the course of a year. If the young are destroyed or removed at birth, there may probably be a litter every month; in one case seven litters were produced in seven months by one female.

There is very little in the way of courtship. Smell seems important in sex recognition. Males fight persistently with [illegible] and [illegible] afterwards try to elude the [illegible] females [illegible], and usually do, resist the [illegible] a little while, but they soon give up the contest. [illegible] period, males will often permit themselves [illegible] punished by the females without injuring them. [illegible] in captivity eat almost fifty per cent. of their young [illegible] mostly, if not always, the females are the [illegible]. They do this even when apparently undisturbed, and even when they are getting meat in their diet. The explanation remains obscure. Brown rats are not full grown before [illegible] fifteen months, but sexual maturity is reached by both sexes not later than the end of the fourth month.

RESULTS OF IMPRISONMENT IN DARKNESS.—J. Ogneff kept gold-fishes in a roomy tank and with plenty of food (earthworms and *Chironomus* larvae), but in absolute darkness. He kept it up for over three years, and then observed the modifications that had occurred in the fish. The colour first became black, but after the second year it became golden again, and the reason for this is interesting. In the first instance the dark pigment-cells spread out, and covered up the subjacent layer of crystals which gives the gold fish its golden sheen. In the second instance the phagocytes devoured the dark pigment-cells and thus re-exposed the golden layer. The changes in the eye were even more interesting. The structure of the pigment-epithelium of the eye was completely altered, and there was a complete disappearance of the rods and cones, and of some other characteristic layers of the retina. Profound atrophy of the eye occurred. The fish became totally blind. Ogneff's experiment suggests that an individual fish imprisoned in a perfectly dark cave would become blind. But it does not throw any direct light on the origin of a blind race of fishes in caves.

DEFENCES OF BIVALVES.—Everyone is familiar with the elaborate outgrowths from the surface of some Lamellibranch shells, which seem like a waste of shell-making material and energy. Mr. Cyril Crossland propounds a theory of their significance,—that they are often protective. In some species they are larger in the young forms and they are of value during the relatively more active period when the young pearl-oyster, or Avicula, or Tridacna is crawling about and seeking a suitable place for settling down on. An enemy like the shell-eating fish Balistes prefers those with weaker shells. Another enemy, the boring Gasteropod Murex, kills more of those with smoother shell. Thus it kills large numbers of *Margaritifera mauritii* which has small and weak processes, but few of *Margaritifera margaritifera* which has large strong processes remaining well-developed for at least six years. It seems that the strong processes prevent the Murex from readily getting a firm hold with its foot, and without this it cannot work the drill in its proboscis. Mr. Crossland explains how the Murex often kills the bivalve without boring. "It finds the flexible edge of the shell, then by contractions of its foot breaks a piece away. The mucus of the foot-glands is then poured out in quantities, and this has some poisonous effect, as the animal, while still untouched, ceases to respond to the stimuli which ordinarily cause a smart closure of the shell."

SENSITIVENESS OF SEA-URCHINS' PEDICELLARIAE.—In experimenting on the sensitiveness of a sea-urchin (*Toxopneustes variegatus*) to a shadow cast upon it in the water, Dr. R. P. Cowles discovered a remarkable fact—that the snapping spines or pedicellariae react quite definitely even after being cut off from the body. There are two kinds, big and little, which respond differently to stimulus. One of each kind was placed in a large dish of sea-water, and exposed to direct sunlight; the large pedicellaria opened its jaws, and the small one shut its jaws. When, however, a patch of shadow was thrown upon them, the jaws of the former closed while those of the latter opened. The change of the reaction resulting from a change in the intensity of the light stimulus was repeated many times with these two pedicellariae. The experiment proves that the pedicellariae act independently of the radial nerve, and confirms the view of von Uexküll that the pedicellariae have the dignity of a reflex person.

FIGURE 124. Halley's Comet, May 4th, 1910. In the dark night and clear air of New Zealand, the end of the tail appeared fully twice as wide as in this photograph.

THE NEW ASTRONOMY.

COMETS.

By PROFESSOR A. W. BICKERTON.

THEIR OCCASIONAL MAGNIFICENCE.

WHEN one has seen Comets at their greatest magnificence, there is no cause to wonder that during the long ages of ignorance these celestial visitants should have been looked upon with awe and fear. Sometimes they seemed to be fiery chariots to carry the soul of the dead hero to eternal glory, or as portents of disaster to tell men to repent and to change their evil ways.

When a youth, I saw Donati's Comet as a vast luminous scimitar stretching from zenith to horizon, its vast dimensions dwarfing everything. I remember how toy-like the trees and houses looked in contrast with the vast immensity of this superb comet. Then again, the same effect repeated itself with the recent visit of Halley's Comet; only as I saw it in the Antipodes, Halley's Comet was still bigger than Donati's. At its best it subtended an angle of fully one hundred and ten degrees. In the early morning, as it rose, tail first, it had the appearance of a broad silvery aurora springing up and covering a great width of the Eastern horizon. Gradually as it rose it narrowed and increased in intensity. It was many hours before the head came into sight and the whole majestic spectacle revealed itself. (See Figure 125.) When fully in sight the dawn took something from its brilliancy, but even when thus diminished it was a memorable sight. Strange that its appearance should have been so insignificant in England. This may have been partly due to the haze in the air. When one is first in New Zealand, the extreme clearness of the atmos-

FIGURE 125.

Diagram illustrating the path of the Comet. The dotted line represents the orbit of a comet. The diagram shows the radial direction of the tail from the sun, the retardation of its distant part into a curve.

pheric distortions of capacity of judging distances. Many a time I have asked tourists, who were standing on the terrace of my house, the distance of the Southern Alps; the answer seldom exceeded ten per cent. of the reality, miles away. Nor do I think the idea that the Galaxy originated in the impacts of two previously existing sidereal systems would ever have occurred to me in England. I have been here nearly one-and-a-half years and have looked times without number, yet never have I seen the outline of the Milky Way so clearly as to suggest the idea of that centrifugal motion that came with such overwhelming force to me as I examined the Southern sky. If we could join with other rational nations and bring about reduction of armaments, and then, if the people of England, with a true imperial spirit, should act together with our overseas dominions, and with the price of a Dreadnought erect an observatory under those clear Antipodean skies, such an establishment would enable the many unsolved problems of astronomy to be hopefully attacked. Excuse the parenthesis, but the New Zealand skies are the true field for celestial observation.

FINDING COMETS.

The keen artistic eye of the astronomer readily detects a change in the stellar pattern. Perchance he sees a new speck of light helping to fill a former void. "What is it?" he asks. Is it another planet or an asteroid? Is it a new star or a comet? If it is a planet or an asteroid, it will probably be found among the Zodiacal constellations in the plane of the ecliptic. If a nova, it will probably approximate to the plane of the Milky Way, and occupy a permanent position among the stars. If a comet, it may be anywhere; but because many of the periodic comets have been caught by the entrapping action of the planets, those whose orbits approach near the Sun will tend to aggregate towards the plane of the ecliptic.

After a time, our astronomer, who has detected the new spot of light, finds it changes its place among the stars of the constellation; hence it is not a nova. If it begins to show a considerable and hazy disc, with a distinct nucleus, it is probably a comet. Then as it approaches the Sun a tail generally appears. It has now all the characteristics of a comet, and so is declared to be one by the astronomical world. Then many other optic tubes are directed to further study its character and to plot its orbit, to photograph its form and study its spectrum.

NORMAL COMETS.

Let us now examine what the countless observations of the astronomers and spectroscopists have to tell us of the salient characteristics of a normal comet. Then we will use our powers of induction and deduction on this assembled set of observational facts, and, using also the accepted physical forces and laws of nature, try and formulate an explanation of the wonders of normal comets and treat further these explanations in the light of those that show abnormal characters; remembering always that it is the normal that is our true study as regards comets or any other special phenomena which we are attacking. The abnormal we must use as being chiefly of value in tending to reveal undiscovered cosmic forces and unrevealed laws of nature, such as have been so prodigally opened to our imagination within the last decade or so.

Let us examine the normal comet and try to fathom its mystery.

A NORMAL COMET.

It consists of a nebulous star-like body or head, with an immense luminous plume or tail; the tail is frequently curved, it is not infrequently multiple, and where its several parts are unequal in volume the thinner portions tend to be the straightest.

As the comet travels in its orbit, the tail is almost always directed away from the Sun. The tail is generally curved in such a way as to suggest a lag, as though the tail had been produced by an impulse, and the luminous effect had taken time to travel. The appearance of some comets is not altogether unlike a rocket, but the rocket leaves its tail behind it, whilst the comet travels with its tail side on. The nearer to the Sun the greater the tail grows to be. Figure 125 shows the normal character of a comet as it passes the sun in the perihelion portion of its orbit.

The drawings of many comets show a kind of series of partly ensphering shells being projected from their heads towards the sun.

TENUITY OF COMETS.

The head even of a comet is of extreme tenuity, so that stars have been seen completely through some of them in their densest parts. Comets have also passed in front of the Sun, yet no sign of any eclipse effect has been seen; nor even the slightest darkening has been observed. These two facts, combined with others, suggest that comets are of the character of a swarm of meteors.

A comet has been known to part into two, and travel as distinct parts, and finally dissipate altogether. The Earth in its orbit intersects the orbits of some comets, and on the days of nearest approach the sky is lit up with a brilliant display of meteors, with an effect as though they shot in every direction from a radiant point. (See Figures 126 and 127). Some of these displays have been of extreme brilliancy and beauty. Astronomers and travellers who have seen such phenomena at their best, describe them as of such superb grandeur as to outshine the most magnificent pyrotechnic display. Those of us who have seen only ordinary examples of these exhibitions, know how glorious even such sights are.

Comets appear to shine by reflected light, but as their luminosity often increases more quickly as they approach the Sun, then the law of the inverse squares suggests they probably become self-luminous as they become subject to the Sun's tidal action and the heat of impact, and as the light of electricity produced by friction is developed.

The Mass of Comets.

Comets have approached very close to planets and their moons, without any disturbing effect having been able to be demonstrated: hence in a cosmic sense they cannot be of great mass. All the evidence suggests that they are small meteoric swarms, so small that they have been called "pinches of cosmic dust." But our earth has also been called "a speck of cosmic dust," yet we know its mass is far from insignificant.

So with the comets. It appears to me that their real mass must be considerable; for unless there were great mutual attraction, the Sun's differential pull on their several constituents must disperse them. Had they fully one-millionth the mass of the Earth it is probable that under the conditions observed their perturbing action could not be measured. Yet such a meteoric swarm would have a mass of six thousand millions of millions of tons, and this I imagine is what we must accept to be the order of the mass of a normal comet. Although the passage of the earth through a comet's tail has not been able to be detected when such an event has occurred, if the earth were struck by the actual nucleus of a comet, I imagine the inhabitants would have a very warm time, with possibly no one left to tell the tale of its temperature.

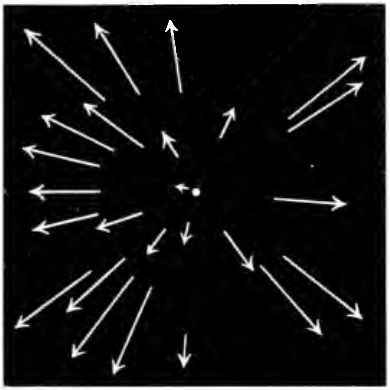


Figure 126.

The above diagram illustrates a set of parallel meteors, a part of a train, plunging into our atmosphere. The apparent radial direction is an effect of spherical perspective, as is also the lengthening of their curves, as they increase in distance from the radial point.

Figure 127.

A Meteor heated by friction of the atmosphere and its volatilized train. It has not yet split or exploded. Meteors frequently do so, and the parts scatter.

Disturbance and Distortion of Comets' Tails.

The tails of comets not infrequently seem to be subject to a tearing or distorting action. They sometimes temporarily split into parts, or become irregular and roughly nucleated. They appear to be encountering some disturbing force in their passage through space. (See Figure 128).

The Orbits of Comets.

The orbit of the majority of comets is either elliptic, or closely approximates to a parabola. This might be expected: because even supposing fully sixty per cent. of comets were hyperbolic, we might reasonably expect to appear to see ten or even fifty times as many that were not hyperbolic; as once a comet is entrapped it will appear again and again, whilst an hyperbolic comet comes once and goes for ever.

Our solar system has probably had some scores of millions of years in which to entrap comets. Hence it is of supreme importance to very carefully look for hyperbolic comets. The discovery of even one in a lifetime would be important evidence, and tell us much of the origin of these bodies.

The Spectra of Comets.

A good deal of conflict seems to exist as to the spectra of comets. There has always been a tendency to ascribe much of their observed effect to carbon and its compounds. Professor Fowler has quite demonstrated the existence of carbonic oxide in both the heads and tails of some comets: but we require to know a good deal more than we do about comets' spectra.

The Surprising Variety of the Phenomena Presented by Comets.

The above are some of the more salient and characteristic properties of comets, but they are very extraordinary objects, and they teem with surprises and have extraordinary varieties of structure (See Figures 129 and 131): so varied, indeed, that it looks as though a long time must elapse before all of even their generic characteristics shall be understood and receive a satisfactory solution.

Dense Cosmic Masses.

It is pretty clearly evident that comets are meteoric swarms, and it is almost certainly the fact of their fragmentary character that causes their brilliancy. It seems clear, however, that single bodies of many times their mass might easily pass through our system without their being seen. When such a dense mass struck the Sun it would act as a detonator, that would cause the solar energy to develop a most surprising solar disturbance.

Explanations.

We will now try to offer some tentative suggestions to account for some of the manifold characteristics of comets. As we have already shown, it is fairly well established that they are meteoric swarms. We will therefore try to deduce the phenomena that will ensue when such a swarm approaches the sun. The

From a photograph *by E. E. Barnard.*

FIGURE 128.

Comet 1908, III. September 30th, 1908, 47 minutes' exposure. Comet's tail showing distortion.

particles composing the swarm are almost certainly kept in leash by mutual gravitation. Every meteor has an independent orbit.

Almost certainly the constituents occasionally collide, even in distant space. Suppose the swarm has approached the Sun, each particle is falling towards him independently of the others, yet acted on by all the others. Some comets have passed less than a radius away from the Sun's surface. The parabolic velocity acquired by the fall of each particle to this position would be of the order of close on three hundred miles a second. The near particles would be made to move enormously swifter than those at the distant part of the swarm. Every orbit would be so disturbed that many of the outer ones would stray away from the general mass never to return. They would continue to move roughly in the comet's orbit, not, however, by any means exactly so, and a broad swath of meteorites would be produced. If the comet were periodic, the varied velocity of the particles would cause this field to extend itself until the whole orbit would be more or less spread with the meteors. The crowd of particles would not only extend itself lengthways in the orbit, but would broaden also, gradually spreading space with cosmic dust. It is this spread of material the Earth encounters that gives us the luminous radiant swarms.

LUMINOSITY OF COMETS.

When a comet approaches the Sun, the disturbing action of solar attraction would cause many impacts. These would temporarily spread the swarm with gas and other resisting material: this in addition to the heat of innumerable impacts would cause much friction and result in the development of electricity. Both effects would produce luminosity, whilst solar radiation itself would be reflected. When the comet was near the Sun the latter would also be a great heating factor.

THE ENVELOPES.

In a number of experimental investigations, I have shown that when matter carries off electricity it tends to do so in pulses. The potential gradually rises until it produces disruption. This disruption produces heat. This motion of heated molecules seems to possess the power of taking off electricity, and lowering the potential almost or quite to zero. Then the potential commences to grow again until, once more, discharge takes place. Some such action as this may account for the partially ensphering envelopes that seem to be projected from some comets.

THE TAILS OF THE COMETS.

When we consider all the physical facts, by no stretch of imagination does it seem possible to think that the tails of comets are material emanations projected from the head. Is it rational to think of them as a kind of feather or material plume, attached to the nucleus, that swings around at the pace of scores of millions of miles an hour? Or that it is made up of material particles, projected radially from the Sun the whole length of the luminous plume in each new

From a photograph taken at *The Royal Greenwich Observatory.*

FIGURE 129.

Comet 1908, III. September 29th, 1908, 50 minutes' exposure. The photograph shows a strangely abnormal appearance in the tail, and apparent distortion, perhaps due to electricity in space. The meteoric swarm is probably diffused around a somewhat dense centre.

position the nucleus occupies? No dynamical suggestion, save that of some radiative or electrical phenomenon, seems to satisfy the conditions. The pressure of light has been tried, and does not appear anything like great enough to explain the phenomena. For over thirty years I have examined suggestion after suggestion with no dynamical satisfaction, and nothing but an induced electrical phenomenon seems left as a probable cause. Many facts point to the Sun being an electrified body. The frictional disturbance produced by its tidal action on the cometic particles must produce electrical separation. The like kind is attracted, the other repelled. The phenomenon of ensphering envelopes suggests that the attracted kind escapes, and leaves the comet charged with the unlike kind. Aided by the Sun it produces an induction that acts upon the matter of space, and temporarily separates the two, electric stress producing luminosity. The greater the nucleus the greater the self-repulsion produced, and the slower the impulse travels, and consequently the greater the resultant curve. With subordinate nuclei the self-repulsion is not strong, and the impulse travels faster and the subordinate tail is straighter.

If the head is made up of many orbitally connected nuclei the tail is multiple, the several parts mutually repelling one another. (See Figure 130).

DISTORTION OF TAILS.

Why are the tails of comets sometimes subject to such apparently violent action? Possibly because some passing meteoric swarm has already set up electrical conditions in space.

From a photograph taken at [illegible]

FIGURE 130.

Comet 1908. III. October 3rd, 1908. 30 minutes' exposure. Multiple tails, possibly due to several nuclei.

THE CHEMISTRY OF THE SPECTRUM.

Why does the carbonic oxide show throughout the mass of a comet? Possibly because carbonic oxide

[illegible]

FIGURE 131.

Comet 1901. I. May 4th, 1901. 15 minutes' exposure. Tail produced by an apparently dense meteoric swarm.

may be spread through space. Why is cyanogen seen in the head? Possibly because this compound of carbon is formed at excessive temperatures, as it is known to be a constant constituent of the gases of the blast furnace. Of course, it would burn were there free oxygen, but the existence of carbonic oxide in space suggests that there is none. The whole problem of comets, bristles with dynamical and chemical difficulties; but do not let us use theoretical suggestions obviously inapplicable. Electricity is a subject we are only just beginning to understand. We are only on the threshold of the prodigality of its varied phenomena. The wonderful chemical and luminous phenomena, now being revealed by Strutt, as associated with the varied molecular states of nitrogen under electrical influences; the extraordinary complexities of brush discharges in different gases so long known, but now so much increased by Rafferty's experiments; the varied glow of vacuum discharges in all the richness of their complex phenomena; these are a few of the experimental effects of electricity; whilst terrestrial magnetism, the corona, the aurora and the varied complexity of the tails of comets are probably each a cosmic phenomenon connected with this same most protean and potent agent.

THE ORIGIN OF THE COMETS.

The theory of partial impact and the theory of the third body in all their multifarious conditions and variety as regards density, mass, depth of encounter, and all the other circumstances we have studied in these articles, continually present us with rotary masses of dense gases, from which selective molecular escape has removed the light gases. Such rotary nebulae tend always to become at a certain stage meteoric swarms. A couple of minor planets grazing would inevitably produce a meteoric swarm. The ends of the spindle of the third body of colliding suns we have deduced would be largely iron, and would tend to segregate into a number of such associated groups of particles, gradually cooling to larger and larger masses. It is a curious coincidence how many of the more massive meteoric blocks are iron. The immense majority of impacts must be oblique, and all grazing impacts must set up rotation, and the heavier elements left by atomic sorting must pass through the meteoric swarm stage. Hence, there is no cause to wonder at the number of comets, nor that space should be rich enough in particles to be lit up when electrical disturbances tend to render cosmic dust luminous. The whole subject of comets, their character and origin, their gorgeous magnificence, the beauty of their ignited meteoric trains, is full of wonder and interest; and this is my excuse for submitting these dynamical deductions as offering suggestions that may be used as tentative explanations of their origin and character.

REVIEWS.

MICROSCOPY.

Modern Microscopy. By M. I. CROSS and MARTIN J. COLE. 325 pages. 113 illustrations. 8¾-in. × 5½-in.

(Baillière, Tindall & Cox. Price, 6/- net.)

The fourth edition of this excellent treatise has now been reached and forms a handbook of considerable value to the amateur microscopist. It would not be difficult to criticise such a work because of its omissions, but such criticism would be obviously unfair. The ground that it attempts to cover is so large, ranging as it does from the use and manipulation of the microscope to the mounting and preparing of objects of widely varying descriptions, that omissions are inevitable; but enough is said in each case to enable a beginner to appreciate the principles involved.

Reference can then be made to larger and more specialized works with a feeling of confidence that the knowledge already acquired may be regarded as sound, and that it will serve as a good foundation.

The first four chapters, forming Part I of the book, are devoted to the microscope and accessories, and sufficiently practical instructions are given to enable a student to start work on proper lines.

It is interesting to see that the concluson is reached that an English microscope is still to be preferred to a Continental one, when really serious and critical work is intended, a conclusion that is in agreement with the opinion of the majority of serious workers in this country. Part II, consisting of Chapters VI to XX, is devoted to methods of preparing, staining, hardening and mounting microscopic objects of all descriptions, and embodies practically all the well-known processes in each branch.

Simplicity is the key-note all through, and it is difficult to imagine in what way the subject could be better dealt with, at least considering the limitations imposed. The instructions given are essentially of a practical nature, and the expressed intention is to avoid the use of needlessly expensive appliances.

Part III consists of a series of articles by well-known workers in the particular branch in which each one specializes. The subjects are dealt with, as might be expected, in a masterly manner, but the Chapter XXI, by Mr. Cheshire, on the Petrological Microscope, is particularly interesting. The polariscope is to the amateur a most fascinating adjunct to a microscope, because of the beautiful effects that are to be observed with comparative ease, but it is almost astonishing to notice that in a great number of cases the user has no idea of the elementary principles involved. Mr. Cheshire has written a simple and lucid explanation of the subject that cannot fail to be of exceptional service, and that has the particular merit of giving a concrete notion of what really takes place when light is polarized. In general, the book is so evidently the work of earnest workers, that it may with confidence be commended as a safe guide for those entering on any field of work that involves the use of the microscope.

J. E. B.

PSYCHOLOGY.

Introduction to Psychology.—By ROBERT M. YERKES. 427 pages. 12 illustrations. 8-in. × 5¼-in.

(G. Bell & Sons. Price 6/6 net.)

Professor Yerkes is well-known for his careful and critical work in comparative psychology. He here provides an outline sketch which is intended primarily to give students a general view of the subject-matter, aims, methods, values and relations of the science of psychology. The book is carefully planned; enough detail is given to make the outline sketch a picture, but not so much as to hide the unity of plan; psychological methods of generalisation and explanation are brought into relation with the methods employed in other branches of science; class exercises involving experimental work and introspection are provided; and throughout the specific psychological aim is kept in view. Especially praiseworthy is the insistence on the fact that psychology is a science in the making. The student is helped to realise that correlations can only be established gradually step by step; that the complex concatenations of the mental life are often such as at present defy analysis; and yet that what has already been accomplished affords ample promise of further success on lines which are strictly scientific. The last part of the six into which the work is divided deals with the practical problem of the aid given by psychology to the control of the mental life, and touches on eugenics and education.

C. Ll. M.

NOTICES.

BIRKBECK COLLEGE. The Governors, Staff and Students of the Birkbeck College are uniting to present Mr. James C. N. White, Chairman of the Governing Body, with his portrait, painted by Mr. Seymour Lucas, R.A., to mark the completion of fifty years' connection with the College. The Secretary of the College would be glad to send particulars to anyone desirous of taking part.

MICROSCOPY. Dr. Charles E. Gabell, Analyst to the Iowa State Food Commission, has written a book of which the first part deals with microscopy and the second with the microscopical examination of drugs. It can be used in connection with any biological work, but is intended more particularly for the use of pharmaceutical and medical students.

SPECTROSCOPES. We have received a leaflet from Messrs. Adam Hilger, Limited, which describes spectroscopes and etalons. The first of the latter is a glass interference form for use with the direct vision pocket spectroscope, showing the Fabry and Pérot ring system. The second, which bears the name Fabry-Perot etalon, can be used with any spectroscope.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

APRIL, 1912.

A SIMPLE RECORDING DEVICE FOR ATMOSPHERIC ELECTRICITY.

By CHARLES E. BENHAM.

A SIMPLE form of recording instrument for use with any apparatus that collects atmospheric electricity is of great assistance in studying the subject. The form of collector may be either the water-dropping apparatus invented by Lord Kelvin, or preferably the more recent collector patented by Mr. F. H. Glew, in which the ionisation properties of radio-actives are ingeniously made use of to enable the collecting rod to take up the charges from the atmosphere. The wire from either of these forms of collector may be led through a carefully insulated plug of sulphur into a room to affect a gold leaf electroscope there, and by the attachment here to be described the charges may be made to register themselves automatically.

The first essential is a sort of relay which will operate whenever the atmospheric electrification rises to a given potential. A balance of light wire is made in the form shown in Figure 132, about six inches in length, the extremities being brought just below the level of the axis, so as to ensure stable equilibrium and considerable sensitiveness. One end terminates in a plate of copper foil about two inches square. The other end is soldered to a fine steel needle attached vertically. The axes are two fine points, which rest in a grooved strip of brass, as shown in Figure 133. A counterbalance on the wire is adjusted till the balance will rest horizontally. Underneath the end bearing the steel needle is a small cup of mercury, the needle point being poised about one-sixteenth of an inch above the surface. Under the copper foil at the other end is a metal plate of the same size, insulated and connected with the atmospheric collector. It should be about one-eighth of an inch below the copper foil. It is evident that any electrification of the metal plate will attract the copper foil, and if powerful enough will draw it down until it touches and discharges the lower plate, when it will rebound and cause the needle at the other end to dip into the mercury cup. Wires are attached to this cup and to the central brass strip supporting the axis of the balance, and these wires communicate with a dry cell and an electro-magnet, which is thus brought into action every time the balance discharges the electricity of the collector.

FIGURE 132.

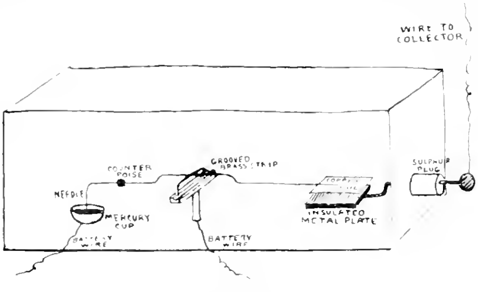


FIGURE 133.

The electro-magnet acts upon an armature that is fixed into a small block of wood mounted on the end of a flat spring about four inches long, so that the block is then [illegible] from the [illegible] (see Figure 134). The top of the clockwork [illegible] velvet and surmounted by a light [illegible] with [illegible], as shown in the diagram. The [illegible] is centrally [illegible] by [illegible] that rest on the velvet. The pen is a glass tube drawn to a point in a flame and sealed, [illegible] being then ground down carefully until the aperture is just [illegible]. In fact, the same sort of pen as used in [illegible] barograph, and almost any ordinary [illegible] can be used, preferably with a little gum to prevent too free a flow. The pen-point is allowed to rest on a clock face so as to trace a circle upon it once in twelve hours. At every discharge of the electricity in the relay the electro-magnet is brought into play and the pen-lever on its wooden support is quickly drawn aside, so that a line across the circle is traced. The number and proximity of the cross-lines will, therefore, be proportionate to the amount of electrification of the air, and the exact time of each discharge will be shown by the hour-lines on the dial-face.

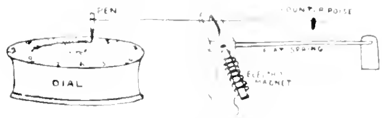


FIGURE 134.

If any difficulty is experienced in making the glass pens the tracing can be done on smoked paper with a needle, but the ink records are obviously more convenient and more easily preserved.

Suppose the apparatus to be set to discharge whenever the potential difference rises to, say, two hundred and ten volts. This can be arranged for by a little trial with an electric light main of that voltage, the distance between the copper foil and the metal plate below it being adjusted until the two hundred and ten volts just suffices to attract the upper plate down to the lower. This having been arranged, it follows that the record of cross lines on the dial will mean that every cross line corresponds to the moment at which the potential difference of the atmosphere is sufficient to charge the instrument up to two hundred and ten volts, when it automatically discharged or overflowed. The comparative frequency of the lines in a given interval of time indicates, therefore, the electric condition of the atmosphere.

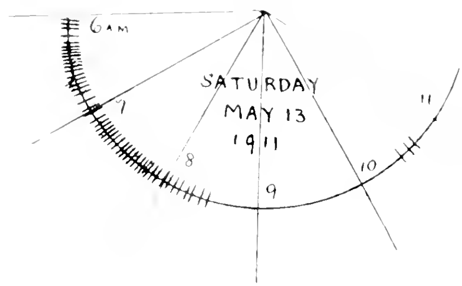


FIGURE 135.

The adjustment of the distance between metal plate and copper foil may be conveniently made by laying thin lead or brass strips on the lower plate until the required level is reached, and the final adjustment may be effected by tilting the relay very slightly by means of a thin [illegible] the other end. [illegible], the record [illegible] of the [illegible] of the atmosphere [illegible], a somewhat [illegible] point from [illegible] aspect, but [illegible] disturbance the [illegible] is reliable [illegible] and is very [illegible] constructed.

A specimen of a typical record under normal condition of the atmosphere is reproduced herewith. (See Figure 135.) Should the electrification be so intense as to make the lines repeat themselves with such frequency that they run into each other, a small Leyden jar may be attached to the collector so as to increase its capacity, and consequently extend the time taken to bring it up to the critical potential difference.

One of the first difficulties with this recorder is the tendency of the relay needle to adhere to the mercury instead of springing back to its position of equipoise, and the result may be that the battery will run down. But this generally results from setting the instrument too close, so that after the discharge it touches the mercury too lightly to withdraw automatically. An effective way of preventing the adherence is to interpose a small trembler bell in the circuit, the bell resting on the top of the relay. It will, of course, ring every time a record is made, and its vibrations, communicated to the needle in the mercury, will act like a decoherer. The bell also has the advantage of adding slightly to the resistance of the circuit, and thus of somewhat lessening the strain on the battery. Two dry cells are ample, and one will generally suffice.

Perhaps the chief difficulty in the whole science and art of collecting atmospheric electricity is that of preventing spider lines from earthing the outdoor part of the collector itself, especially at certain seasons of the year. A single gossamer is enough to stop all signs of electricity, and no matter how high the collecting pole may be it is never out of the reach of the spider, which has a habit of making its web at night, when the automatic recorder should be of the greatest value. Even a coat of bird lime on the pole does not stop the spiders. With a radio-active collector made in windmill form, the difficulty is almost entirely surmounted as the web is broken by the revolution. With the water dropping apparatus, there seems to be no satisfactory way of guarding against spiders' lines.

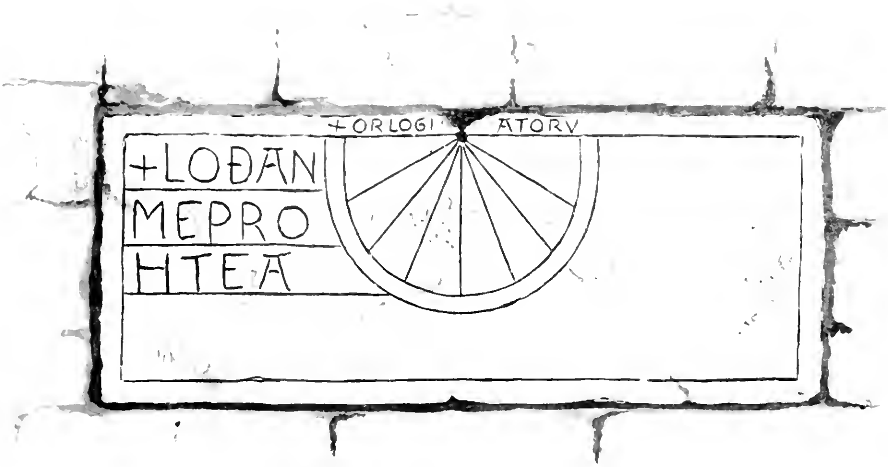


FIGURE [illegible]. A Sun-dial at Great Edstone.

SAXON SUN-DIALS, MASONS' MARKS, AND CONSECRATION CROSSES.

By LEO L. W. GAYE and ARTHUR GALPIN.

THE curious markings frequently found on, or near, the South Porch of pre-Reformation churches—usually from three feet to six feet from the ground (Figure 137)—have puzzled nearly everyone who has noticed them: and a recent visitor to the parish church of Skeyton, in Norfolk, wrote to a provincial newspaper, asking if anyone could tell him the origin and use of what he had heard described locally as the "Sun-dial." A correspondence was continued for upwards of three months, and showed not only that the subject is interesting to a very large number of persons, but that the utmost confusion exists as to what these "Dials" really are. "Masons' Marks," "Consecration Crosses," "Protractors," and "Sexton's Wheels" were in turn suggested: the only point of agreement being that they are *not* Sun-dials! At the close of the correspondence the writers of the present article began to investigate the subject, and the result of their search for information (in which they have been assisted by clergy and laymen in all parts of Great Britain) has not only proved most interesting, but they have succeeded in answering the original question—"What are these 'dials' and how were they used?"

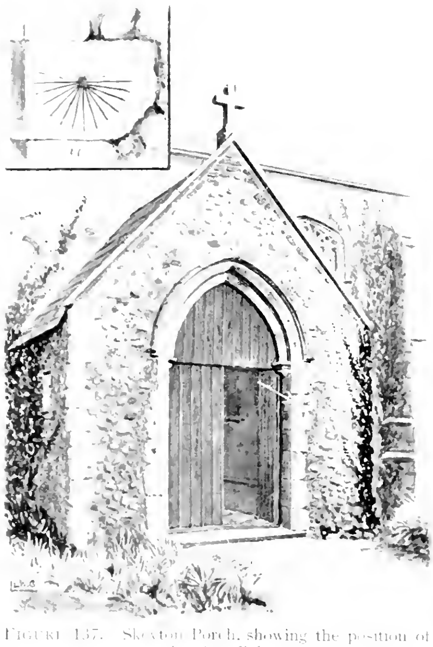


FIGURE 137. Skeyton Porch, showing the position of the Sun-dial.
The Dial enlarged is shown in the inset

In considering this subject it is necessary to constantly bear in mind, first of all, the ways of the post-Reformation church restorer. To him is due the "migration of stones," and he appears to have acted upon some such rule as "Here's another stone with something on it: better not throw it away: stick it in *somewhere*: it doesn't matter where" . . . . and in it went! An instance of this is seen at All Saints', Norwich, where five of the original

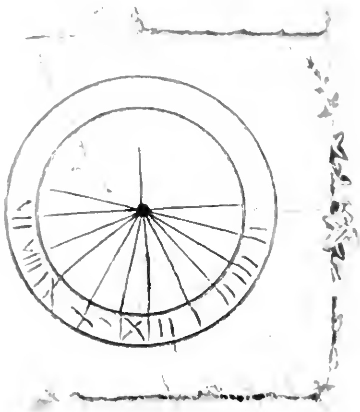


FIGURE 138. A Sun-dial at Swardeston.

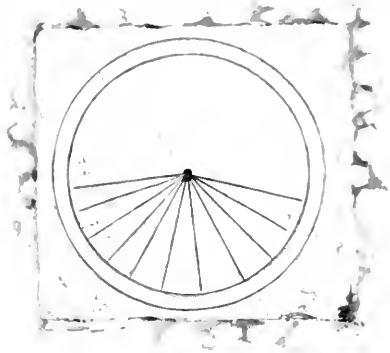


FIGURE 139. A Sun-dial at Great Easton.

consecration crosses (Figure 142) are now in the *outside* wall! This is also the easy explanation of sun-dials being found *inside* churches. Secondly, we must remember that the "Reformers" and their immediate successors have left their trace everywhere; scarcely anything which is sacred or even that which is simply ecclesiologically interesting appears to have escaped them. One finds consecration crosses mutilated, "embellished," and duplicated; sun-dials duplicated (more or less faultily) and originals either mutilated or "improved" by added radii, and so on;

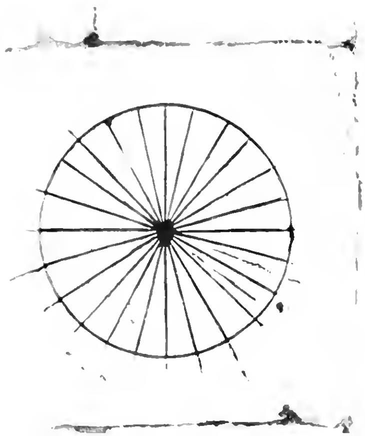


FIGURE 140. A Sun-dial at Tacolneston.

in fact, where the examples are well weathered it is often extremely difficult to distinguish the true from the false.

The suggestion that Saxon dials are consecration crosses found many supporters, but that they were mistaken is easily shewn. The consecration of a Catholic church is a most interesting ceremony occupying several hours, and as all the churches directly or indirectly referred to are pre-Reformation, a brief reference to the crosses (Figures 142, 144 and 147 and 148) will be interesting, and will explain what proved a difficulty to so

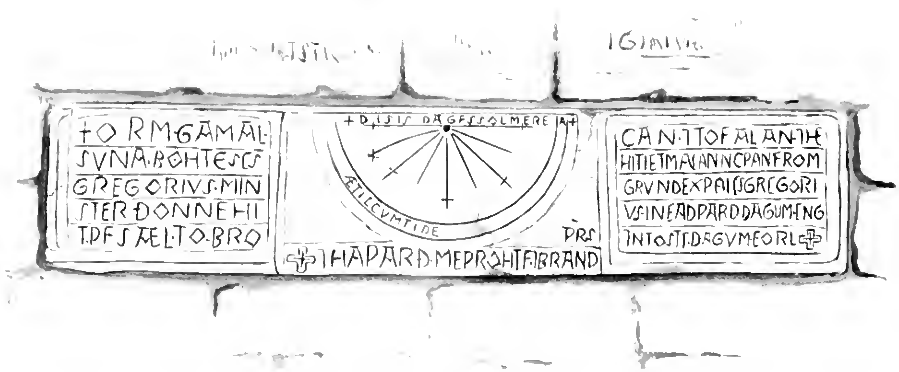


FIGURE 141. A Sun-dial at Kirkdale.

many persons. There are twelve crosses upon the inside *walls* (not on the pillars or columns) —one each side of the main entrance, one each side of the sanctuary, and four upon each side wall. They are seven-feet six-inches from the floor and are sometimes painted upon the walls, sometimes of metal let into the walls, and sometimes cut into the stone (or, if the walls be not of stone, cut into inserted stones). A metal, or wood, sconce (in which a candle is kept burning

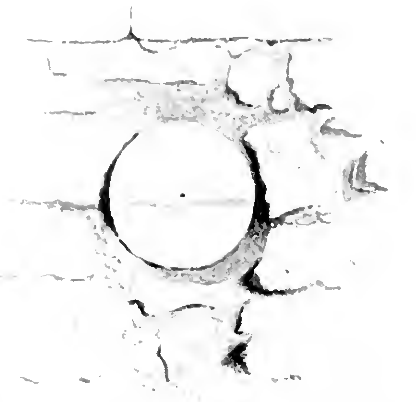


FIGURE 142. Consecration Cross at All Saints', Norwich.

FIGURE 143. Consecration Cross at Rockland, St. Mary.

FIGURE 144. Consecration Cross at Skeyton.

from the beginning of the consecration ceremony until the church is closed at night, also all day on the anniversaries of the consecration) is fixed above or below each cross. An interesting exception to this is seen at All Saints', Norwich, where the sconces were in the *centre* of the crosses (Figure 142) as shewn by the remains of the tangs still visible. In the course of the ceremony these twelve crosses are anointed by the Bishop with his thumb dipped in holy oil (as sometimes is also a cross on both door-jambs of the main entrance. These two (which are four-feet six-inches from the ground and have no sconce) are usually, but not always, cut into the jambs; if the jambs are made of brick two small stones (in which the crosses are cut) are let into the bricks. The large number of crosses sometimes found upon door-jambs puzzled many correspondents (one of whom suggested that they are "Institution" crosses, *i.e.*, whenever a new appointment was made a cross was cut, in commemoration, upon the jambs), but this duplication has been explained when speaking of the "Reformers" as also is the eccentric form some of the original crosses now take.

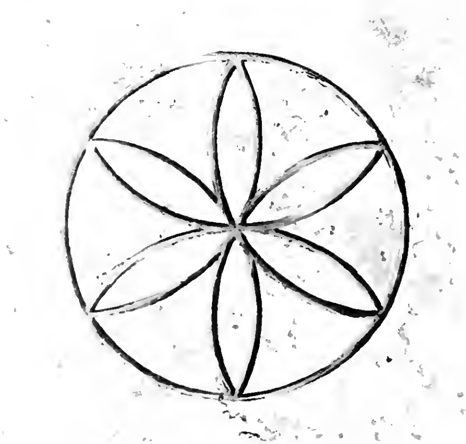


FIGURE 145. Mason's "mark" at Claxton.

Those persons who believed the Saxon dials to be "Masons' Marks" were equally mistaken. "Masons' marks" are so varied and numerous as to be countless; and it is customary for a mason to mark, or "sign," his work, just as an artist [illegible] The question of the [illegible] mark [illegible] from time to time. [illegible] in the [illegible] sixteenth [illegible] a [illegible] reason to place [illegible] the [illegible] not [illegible] face of stone [illegible] prior to that period. Figures 151 and 152 are the "marks" of two well-known [illegible] at present living [illegible] Norwich [illegible] suggests that Figure 149, which is much more frequently met with than most others, is the "mark" of a masons' guild, *not* of an individual mason; and they are shewn on the joint and top bed of stone-work respectively, these being the positions usually occupied by modern masons' "marks."

It was also suggested that the Saxon dials might be primitive "Protractors" by which masons set their "sliding bevels"! In support of this it was pointed out that the angles at which most stones were cut, were multiples of the angle of 15° intercepted by each pair of radiating lines of the dial marks. However, the "marks" selected for illustration (Figures 145 and 149–152), and the many others which have been examined, undoubtedly do away with the [illegible] justification for entertaining that idea. [illegible] from the fact that comparatively few of the [illegible] dials are sufficiently accurately to allow one to suppose that they were ever put to that purpose successfully, stones where accuracy was of any moment would in all probability have been cut to the required angle before leaving the mason's "banker" or bench, and therefore the existence of such a protractor on the site would not be necessary. A measure of proportion by which the parts of an order or of a building are regulated in *classical* architecture also seemed destined to be confused with sun-dials. The measure in question is termed a "module": it consists of a diameter or semi-diameter of a column and is divided up into sixty equal parts (termed "minutes"). So far as can be discovered the *circumference* of a column has never been taken as the module, but some persons may have had its division in mind when likening such a scale to a sun-dial.

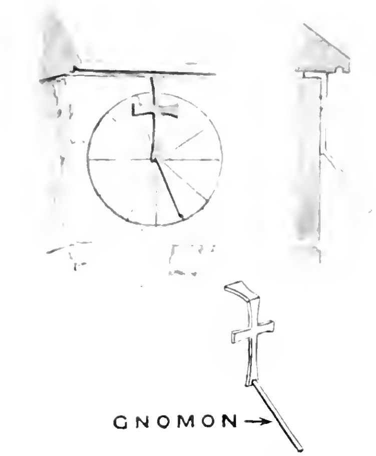


FIGURE 146. Mr. Arthur L. C. Bentley's "Conjectural Method of Fixing the Gnomon."

SUN-DIALS.

The Saxon sun-dials which sometimes have a double and sometimes a single outer circle (Figures 139

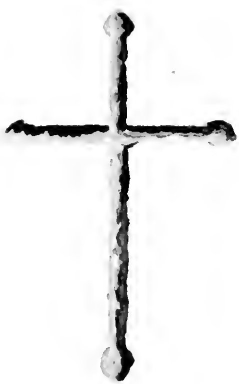


FIGURE 147. Consecration Cross at Kirby Bedon.

FIGURE 148. Consecration Cross at Claxton.

and 140) and which sometimes consist of radii without a circle or semi-circle (Inset in Figure 137), are very much more widely distributed than may be supposed. It has been said that they cannot be *sun*-dials because in very many instances the radii or the spaces cannot be assigned in any possible way to the twenty-four hours of the day. But it must be remembered that "Time" has not always been computed as at present: there have been many quite distinct notations of time, and *our* division of the day into twenty-four hours is comparatively modern. The Saxons divided it into "Tides," each of three hours, and their earliest dials which are semi-circular (Figure 141) mark four tides (day-time). The circular dials marking eight tides (day and night) came later. At a later period these divisions were sub-divided and, still later, further sub-divided until at last they were brought into conformity with the twenty-four hour method. Some persons say "as the sun cannot throw a shadow upward these dials cannot be *sun*-dials," but the reply to this appears to be that having selected the chariot wheel as the shape or form of the sun-dial it was natural to use the complete form even though only the lower half was needed. Apart from that, the complete "wheel" possibly often proved useful in enabling a person to determine the position of the hours at a glance notwithstanding the general absence of figures. But that this was a question of completeness rather than anything else is shewn by the Great Edstone, Great Easton, and Kirkdale (see Figures 136, 139 and 141). The former although circular has only the lower radii cut, both the latter are semi-circles. It has sometimes been said that certain dials cannot be Saxon because they were obviously made at a later period; but the term "Saxon" refers to the notation, not necessarily to the workmanship. The varying spacing of the lines on Saxon dials has been the cause of much perplexity to those who have failed to notice a much greater variation in modern sun-dials, usually owing to the orientation of the building (or—more correctly—the declination of the dial). Churches are invariably built approximately "East and West," but secular buildings cannot always be placed according to that rule; therefore the modern sun-dials which are found upon private houses, schools, and so on, vary to a much greater extent than do the Saxon dials found upon churches. Although a very large number of Saxon dials still have the tang of the gnomon embedded in the stone, most careful search has failed to discover one with the original gnomon intact (which is not surprising when their age and exposed position is remembered). Because the tang is horizontal many persons believe the only possible gnomon was a horizontal one, and that therefore the dials cannot possibly be *sun*-dials; but this error is probably the outcome of having heard, or read, the erroneous statement, "The gnomon *must* be parallel to the Earth's axis." (The angle or otherwise of the gnomon makes no difference to the possibility of reading time. Perhaps the

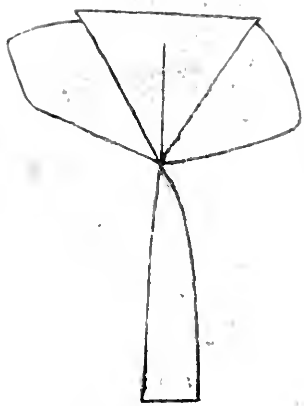


Figure 149. Mason's "mark" at Trowse.

Figure 150. Mason's "mark" at Hellington.

that probably [illegible] the Saxon dials are [illegible] the Great Edstone, [illegible] Kirkdale (Figures 136, 138, 139), and [illegible]. In the majority of instances [illegible] dials, i.e., the dial without inscription [illegible] but the two former have an inscription [illegible] contemporaneous with the dial [illegible] of the latter have *figures* denoting [illegible]. In the centre panel of the Kirkdale [illegible] the inscription (translated) tells us, "This is [illegible] sun-marker at every Tide," and that [illegible] on the Great Edstone dial (a sketch

FIGURE 151. The "mark" of a mason living in Norwich.

of which was very kindly sent by the Rector) describes it as the "Clock of Travellers." In instances (of which there are many) where the radii cannot be assigned to any known notation of time, ecclesiastical (e.g., the canonical hours) or secular, the explanation will probably be that they are due to the "Reformers."

The finding of Saxon dials which have no hole (and obviously never had one) for fixing a gnomon has been claimed as convincing proof that they are not *sun*-dials; but Mr. Arthur Bentley's "conjectural method of fixing the gnomon" (Figure 146), which is reproduced by his kind permission, has most effectually explained that difficulty.

It is interesting to notice how easily Figures 142–145 may be mistaken for Figure 140, as all three examples are very much weathered, and a casual observer would probably notice practically no difference. Figure 140 is one of the Tacolneston dials, Figure 142 is a consecration cross (All Saints', Norwich), and Figure 145 is a mason's mark (Claxton).

The [illegible] Orientation (previously referred to) is frequently misunderstood. It is very usual to say "Churches are built East and West," but comparatively few persons know that very few are due East, and that there is generally quite sufficient variation to make the adjustment of the markings of a sun-dial necessary. The variation is caused in this way: The foundations of a church are laid according to the position of the sun on the patronal feast; therefore a church dedicated to, say, St. John the Baptist (June 24th) is not in exactly the same position with regard to East and West as one

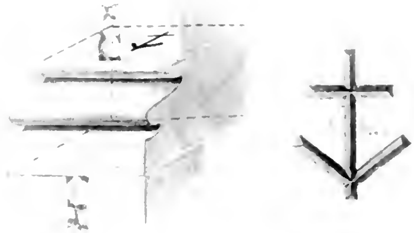


FIGURE 152. Another "mark" of a mason living in Norwich.

dedicated to, say, St. Andrew (November 30th) and this divergence has to be allowed for when marking the lines upon the sun-dial.

Sexton's Wheels (which have been unaccountably confused with Saxon dials) are portable articles, and only two specimens are known to exist (at Long Stratton and Yaxley, both in the diocese of Norwich). They have no connection either in form or use with sun-dials and a very interesting illustrated description of them will be found in "Norfolk Archæology," Vol. IX, 1881.

The authors are greatly indebted to the large number of persons who have not only corresponded but have gone to considerable trouble in making rubbings, sketches, and so on; especially to Mr. R. H. Flood (who lent a very large number of interesting rubbings), and to Mr. Arthur F. C. Bentley (who most kindly made and presented practical models of four primitive sun-dials (set out for the latitude of Horstead, in Norfolk)—and whose "conjectural method of fixing the gnomon" helped them out of what undoubtedly proved one of their greatest difficulties).

THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

[illegible]	[illegible]

TABLE 12.

[illegible]	[illegible]

TABLE 13.

m, *e* denote morning, evening respectively. Greenwich Civil Time (day commencing at midnight) is used. P is the position angle of the body's North Pole measured eastward from the North Point of the disc. B, L are the Helio-(planeto-)graphical latitude and longitude of the centre of the disc (N. latitudes +). In the case of Jupiter there are two systems of longitude, the first for the equatorial region, the second for the temperate zones.

T denotes the time of passage of the zero meridian. Intermediate passages for Mars, Jupiter I and II may be found by applying multiples of $24^h\ 39{\cdot}7^m$, $9^h\ 50{\cdot}4^m$, $9^h\ 55{\cdot}6^m$ respectively.

Q, q for Mars are the position angle and amount of the greatest defect of illumination.

THE SUN continues his northward march, but with slackening speed. During May the semi-diameter changes from 15′ 53″·6 to 15′ 47″·8; Sunrise $4^h\ 34^m$ on 1st, $3^h\ 52^m$ on 31st. Sunset $7^h\ 20^m$ on 1st, $8^h\ 3^m$ on 31st. As this is probably the year of minimum, sunspots and prominences are few and small.

MERCURY is a morning star throughout the month; being south of the Sun it is better placed for observers in the southern hemisphere. It is in elongation 26° from Sun, May 13th. The semi-diameter diminishes from 5″ to 3″, the illuminated portion of disc increases from ½ to ⅘.

VENUS is approaching superior conjunction, and is too near the Sun for convenient observation. Semi-diameter 5″, $\frac{99}{100}$ of disc illuminated.

THE MOON is full May $1^d\ 10^h\ 10^m$ *m*. L. Quar. $9^d\ 0^h\ 56^m$ *m*. New $16^d\ 10^h\ 14^m$ *e*. F. Quar. $23^d\ 2^h\ 11^m$ *e*. Full $30^d\ 11^h\ 30^m$ *e*. Apogee $7^d\ 8^h$ *e* (semi-diam. 14′ 48″); Perigee $19^d\ 5^h$ *e* (semi-diam. 16′ 24″); Maximum Librations 5° W. April 30^d, 7° N. May 6^d, 6° E. 14^d, 6° S. 20^d, 5° W. 26^d, 6° N. June 3rd. The letters indicate the region of the Moon's limb that is brought into view by libration; E. W. mean the East and West with regard to our sky, not as they would appear to an observer on the Moon. Thus W. is the side towards Mare Crisium.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to L.	Reappearance. Mean Time.	Reappearance. Angle from N. to L.
1912			h m		h m	
May 2	BAC 5253	5·4	9.30 *e*	105	10.25 *e*	248
„ 3	BAC 5286	5·4	0. 0 *m*	110	1.20 *m*	201
„ 8	BAC 7677	6·2	2. 9 *m*	59	3.28 *m*	272
„ 20	ε Geminorum	5·5	7.37 *e*	124	8.33 *e*	272
„ 27	BD −13° 3802 ...	6·8	11.15 *e*	136		—
„ 29	BD −22° 3980	6·0	9.59 *e*	61	10.42 *e*	359
„ 29	42 Librae	5·[illegible]	11.55 *e*	159	0.40 *m*.*	244
„ 30	Antares ...	1·3	8.48 *e*	114	10. 2 *e*	290
„ 30	BAC 5513	6·2	9.54 *e*	90	11.12 *e*	302

TABLE 14. Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that given in the date column. From New to Full disappearances occur of the Dark limb, from Full to New reappearances. Attention is called to the occultation of Antares on the 30th. It is low down at disappearance, but fairly well placed for reappearance.

M[illegible] diameter [illegible] N[illegible] of Neptune [illegible]

J[illegible] 1st when it [illegible] The [illegible] telescope at [illegible]

Day.	West.		East.		Day.	West.		East.	
[illegible]	1		3		May 17	4		2	
[illegible]	1		[illegible]		" 18	43			
[illegible]	1	⊙	12		" 19	132		[illegible]	
[illegible]				●	" 20			2	●
[illegible]	1		4		" 21	14		32	
[illegible]			123		" 22	2		143	
[illegible]	1		234		" 23	12		34	
" 8	2		134		" 24			24	
[illegible]	1		31	●	" 25	31	⊙	4	
[illegible]			3124		" 26	32		14	
" 11	321		4		" 27	3		24	●
" 12	32	⊙	4		" 28	1		24	●
" 13	31		12		" 29	2		3	
" 14	41				" 30	4		3	
" 15	42		13		" 31	4		2	
" 16	412		3						

Satellite phenomena visible at Greenwich. $1^{d}\ 11^{h}\ 45^{m}e$ II. Oc. R.; $2^{d}\ 10^{h}\ 43^{m}e$ III. Sh. I., $11^{h}\ 27^{m}e$ III. Tr. I.; $3^{d}\ 1^{h}\ 10^{m}m$ III. Tr. E., $2^{h}\ 31^{m}m$ I. Sh. I., $3^{h}\ 12^{m}m$ I. Tr. I.; $3^{d}\ 11^{h}\ 53^{m}\ 45^{s}e$ I. Ec. D.; $4^{d}\ 2^{h}\ 43^{m}m$ I. Oc. R.; $4^{d}\ 11^{h}\ 13^{m}e$ I. Sh. E., $11^{h}\ 50^{m}e$ I. Tr. E.; $7^{d}\ 4^{h}\ 7^{m}m$ II. Sh. I.; $8^{d}\ 10^{h}\ 20^{m}\ 20^{s}e$ II. Ec. D.; $9^{d}\ 2^{h}\ 3^{m}m$ II. Oc. R.; $10^{d}\ 0^{h}\ 36^{m}m$ III. Sh. I., $2^{h}\ 41^{m}m$, III. Sh. E. $2^{h}\ 40^{m}m$ III. Tr. I.; $11^{d}\ 1^{h}\ 47^{m}\ 24^{s}$ I. Ec. D.; $11^{d}\ 10^{h}\ 53^{m}e$ I. Sh. I., $11^{h}\ 22^{m}e$ I. Tr. I.; $12^{d}\ 1^{h}\ 7^{m}m$ I. Sh. E., $1^{h}\ 35^{m}m$ I. Tr. E.; $12^{d}\ 10^{h}\ 54^{m}e$ I. Oc. R.; $16^{d}\ 0^{h}\ 55^{m}\ 51^{s}m$. II. Ec. D.; $17^{d}\ 10^{h}\ 30^{m}e$ II. Sh. E., $11^{h}\ 10^{m}e$ II. Tr. E.; $18^{d}\ 3^{h}\ 41^{m}\ 8^{s}m$ I. Ec. D.; $19^{d}\ 0^{h}\ 47^{m}m$ I. Sh. I. $1^{h}\ 7^{m}m$ I. Tr. I., $3^{h}\ 1^{m}m$. I. Sh. E., $3^{h}\ 19^{m}m$ I. Tr. E.; $19^{d}\ 10^{h}\ 0^{m}\ 33^{s}e$ I. Ec. D.; $20^{d}\ 0^{h}\ 38^{m}m$ I. Oc. R.; $20^{d}\ 9^{h}\ 29^{m}e$ I. Sh. E., $9^{h}\ 46^{m}e$ I. Tr. E., $9^{h}\ 52^{m}e$ III. Oc. R.; $23^{d}\ 3^{h}\ 31^{m}\ 30^{s}m$ II. Ec. D.; $24^{d}\ 10^{h}\ 33^{m}e$ II. Sh. I., $10^{h}\ 56^{m}e$ II. Tr. I.; $25^{d}\ 1^{h}\ 13^{m}m$ II. Sh. E., $1^{h}\ 33^{m}m$ II. Tr. E.; $26^{d}\ 2^{h}\ 41^{m}m$ I. Sh. I., $2^{h}\ 51^{m}m$, I. Tr. I.; $27^{d}\ 0^{h}\ 3^{m}\ 24^{s}m$ I. Ec. D., $2^{h}\ 22^{m}m$ I. Oc. R.; [illegible] I. Sh. E., [illegible] I. Tr. E. [illegible] III. Ec. D., [illegible] I. Sh. I., 11^{h} [illegible] I. Tr. I., [illegible] $10^{m}m$ III. Oc. R.; [illegible] I. Oc. R.

S[illegible] invisible, being [illegible] with the Sun [illegible]

U[illegible] morning star, better placed for [illegible] observers, [illegible] diameter [illegible]

NEPTUNE is an evening star, [illegible] diameter [illegible] north of Mars on 12th.

METEOR SHOWERS (from Mr. Denning's Lists):

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
[illegible] to May	203	62	Rather swift.
Apr. to May	193	+ 58	Slow, yellow.
" [illegible] to May	200	[illegible]	Swift, streaks.
May 1 to 6	338	2	Aquarids, swift, [illegible]
" 7 ...	240	[illegible]	Slow, bright
" 11 to 18	231	27	Slow, small.
" 30 to Aug.	333	28	Swift, streaks.
" — June	285	32	Swift.
" July	252	21	Slow, trains.
" 18 to 31	245	20	Swift, white.

CLUSTERS AND NEBULÆ.

Name.		R.A.		Dec.	Remarks.
M.	53	13^{h}	8^{m}	N 18 ·7	Fine cluster of small stars.
M.	63	13	11	N 42 ·6	Oval nebula with nucleus.
M.	51	13	26	N 47 ·7	The famous spiral nebula.
M.	3	13	38	N 28 ·0	Splendid cluster.
H I.	70	14	24	S 5 ·5	Cluster of very faint stars.

DOUBLE STARS.—The limits of R.A. are 13^{h} to 15^{h}.

Star.	Right Ascension. h.	m.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
θ Virginis	13	5	S 5 [illegible]	4, 9	343°	7	White, violet.
42 Comæ	13	6	N 18 [illegible]	6, 6	190	[illegible]	Orange.
ζ Urs. Ma.	13	20	N 55 ·4	2, 4	15	15	Yellow.
25 Can. Ven.	13	33	N 36 ·7	5, 8	130	1	White, blue.
κ Boötis	14	10	N 52 [illegible]	4, 6	236	13	Yellow, blue.
Σ 1825	14	12	N 20 ·5	7, 8	173	4	Just North of Arcturus.
Σ 1831	14	13	N 57 [illegible]	6, 9	140	6	White, ash.
Σ 1835	14	19	N 8 ·8	5, 7	192	6	Greenish, bluish.
			The smaller star is a very close double [illegible] apart.				
φ Virginis	14	23	S 1 ·9	5, 9	110	4	Yellow, blue.
ζ Boötis	14	37	N 14 [illegible]	3½, 4	147	[illegible]	White.
ε Boötis	14	41	N 27 ·4	3, 6	320	3	Deep yellow, blue
			Known as Pulcherrima from the beauty of the colours.				
ξ Boötis	14	47	N 19 ·4	5, 6	180	3	Yellow, purple.
39 Boötis	14	47	N 49 [illegible]	6, 6	44	3	White, purple.

NOTE.—"The Face of the Sky," we would remind our readers, is published a month in advance so that when it reaches subscribers and their friends abroad it is in time to be of use to them.

CORRESPONDENCE.

DIVIDING ANGLES INTO THREE EQUAL PARTS.

To the Editors of "KNOWLEDGE."

SIRS,—Your article last month on the above subject I at first thought to be a claim to have solved the outstanding classical problem in Pure Geometry "To trisect a given rectilineal angle," a problem which has interested many of us and wasted many an hour. The approximation of Mr. Bingley's reminds me of one of my attempts which may be sufficiently interesting to record. All your geometrical readers (not then shape), will know that by joining the bisection of a side of a parallelogram to one of the opposite angles, the diagonal is trisected. I fondly hoped that it might be possible to trisect an arc in somewhat the same way with curved it not with straight lines. If we include a right angle in a circle with its centre at the angular point and join through the bisection of one side with the extremity of the diameter of which the other side is a part, the 90° arc is not trisected though there is a suggestion that the line may cut the circle at the apex of the equilateral triangle standing on the other side (see Figure 153), but the angle $\tan^{-1}\frac{1}{3}$ is formed.

This is not an encouraging start, but on applying this to smaller angles good approximations well within the draughtsman's error are reached (see Figure 154).

Let A B C be the given angle. Describe the circle A C with centre B. Produce C B to the circumference at D. Bisect A B at E. Join D E and produce to the circumference at F. The arc A C is *approximately* trisected at F. The word in italics is unfortunate but necessary.

If we try an angle of 120° it is actually bisected, whereas one of 90°, as we have found, comes within 7° of the proper place. Calculation shows that at 60° the error has fallen to 1° 47′; for 45° it is 43′ only, then it rapidly decreases and at 30° it is less than 11′, which is already negligible; the two-thirds angle always being slightly too small.

Mr. Bingley's method, I find, gives precisely the same results, his E J, E K, lines corresponding to my D F though obtained by a more elaborate construction. He, however, bisects his angle first, so that when I speak of an angle 30° his would be 60°.

To prove the relationship of the two methods let us take a

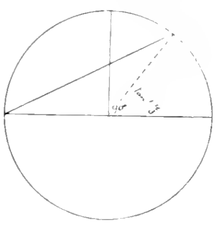


FIGURE 153.

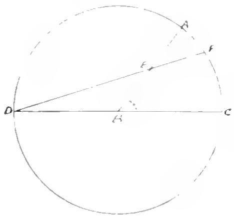


FIGURE 154.

part of his figure, but with a larger angle and a complete circle (see Figure 155 where A D, E C, and G D are bisected).

Take the centre of rectangular co-ordinates at A, the axis of X, A C, and the co-ordinates of D (a, b) where $a^2 + b^2 = 1$.

The co-ordinates of the points will be:

A, (0, 0); C, (1, 0); D, (a, b);

$$E, \left(\frac{a}{2}, \frac{b}{2}\right); \; G, \left(\frac{a+2}{4}, \frac{b}{4}\right); \; I, \left(\frac{5a+2}{8}, \frac{5b}{8}\right)$$

$$\text{Equation to E I:—} \quad \frac{y - \frac{5b}{8}}{\frac{b}{2} - \frac{5b}{8}} = \frac{x - \frac{5a+2}{8}}{\frac{a}{2} - \frac{5a+2}{8}}$$

[illegible]

This [illegible] the [illegible] obviously both [illegible]

Therefore, K I [illegible] produced cuts the circle at Z, and the two constructions [illegible] the same results.

In the above [illegible] the co-ordinates a, b, do not necessarily refer to the [illegible]; the $a^2 + b^2 = 1$, is not used; showing that the point D may be anywhere and K F always cuts the circle at Z! (see Figure 156). Of course the approximation is not

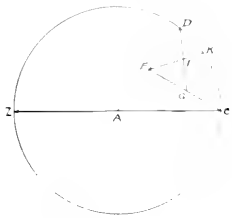


FIGURE 155.

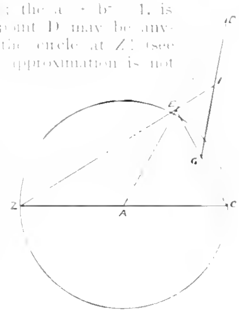


FIGURE 156.

obtained unless D is taken on the circumference. There is no particular mystery about the process finding the circle at last, for C is of necessity on the circle.

The construction of Figure 156 doubles a straight line, C A, by a system of bisections—a rather curious result.

H. F. CHESHIRE, B.Sc., F.I.C.

HASTINGS.

THE TRISECTION OF ANGLES.

To the Editors of "KNOWLEDGE."

SIRS,—I am much obliged for the interest that your correspondents, Messrs. Thomson and "Computer," have taken in this matter, originated by my little article in your November, 1911, issue, and for their corrections and remarks thereon. I only intended the method to apply to small angles of 45° or less, as then stated, as it is not applicable to larger angles. With the means at my disposal, which are, unfortunately, very primitive, I could not detect any error, but I quite accept the corrections, of course, and am only sorry that the method turns out to be inaccurate, or, in other words, not a method at all. As to angles of exactly 45°, 90°, 135° and 180°, surely these are mathematically divisible by a much simpler method than Mr. Thomson's No. 2, *viz.*: the angles 45°, 90° and 180° by that of 60°, and the angle of 135° by that of 90°? I have always so treated them, and should be glad to be shewn any correction that they require.

CHAS. S. BINGLEY.

185, ALBION ROAD, N.

THE FLIGHT OF BIRDS.

To the Editors of "KNOWLEDGE."

SIRS,—The methods of birds in maintaining or rather recovering energy of position during flapless or soaring flight is very easy of observation in the plains of India during the beginning of the hot weather, and the following notes may be of interest to some of your readers less favourably placed as regards opportunities for watching them. The two conditions required, namely, ascending currents of air and a plentiful supply of large soaring birds, are both present. At the beginning of the hot weather, before the more regular winds set in, the air near the surface of the soil is intensely heated during the middle hours of the day, the atmosphere as a whole being more or less at rest. This unstable state of a heated lower layer gives rise to numerous small whirlwinds, locally known as "Dust Devils," varying in size from a few feet to perhaps a hundred yards in diameter, and in duration from about ten seconds to as many minutes or longer. Their appearance on first forming is that of a whirling column of dust, mixed with leaves, straws, and so on, which, after continuing for some time, gradually lose their sharp outline and appear to be more or less dissipated, but the consequent uprush of air can be traced for long afterwards by the cloud of dead leaves hovering far above the surface of the earth. The action is, of course, similar to the formation of waterspouts at sea.

Soaring birds, such as Vultures, Kites and Storks, are common; indeed, it is of very rare occurrence that the sky can be searched for two minutes without discovering at least one Vulture. These, however, are usually at such an elevation that they are useless for the present observations.

A low-flying bird is required, and one is chosen flying across country, perhaps two or three hundred feet above the ground and straight as the proverbial crow.

Observed with good glasses, the wings and tail are seen to be practically motionless as a whole, but with a constant adjustment of the plane angles.

The loss of elevation as it proceeds is clearly noticeable, and if it cannot find an external source of energy it must flap or come to the ground. It need not proceed far, however, before encountering a dust devil uprush, on meeting which the straight flight is changed to a circular one, on which it mounts, still without flapping, to a limit either at which the uprush of air is no longer strong enough, if the dust devil be small, or at which the Vulture chooses to start off again on its straight flight.

It should be understood that the birds do not circle on a dust devil in active operation, as the motion is then extremely violent, but after breaking, as noted above, the vertical current becomes suitable for the birds' purpose. Numerous dead leaves may occasionally be noticed hovering amongst the circling birds.

At times the dust devil movement does not begin by the intense motion as previously stated, but a gentle uprush vortex motion sets in, which gradually drifts across the country. These are frequently occupied by twenty or thirty Vultures, which continue to circle as long as visible. The upward current is detected by the radially inward draught felt when the movement passes near the observer.

In the early morning or late afternoon, when the dust devils do not occur, the Vultures invariably proceed by alternate flapping and soaring flight.

The extent of the bearing power of these upward movements of the air is evident from the phenomena of dead leaves dropping out of the still evening sky, as late as can be observed up to and after sunset, the last dust devil having broken up some two or three hours previously.

Melbourne. S. TULLOCH.

THE SUN'S PATH IN SPACE.

To the Editors of "Knowledge."

Sirs,—The direction of the Sun's path in Space has been calculated with some degree of certainty by observations of "Star Drift." Could not its path be ascertained with a greater amount of accuracy by calculations of the differing positions of the centre of gravity of the Solar System, which must change to some very slight but still appreciable degree, with the relative changes in the positions of the planets?

If, for instance, when the larger planets are in conjunction, or in opposition, or at their perihelion, or at their aphelion, a sufficient number of calculations were made of the consequent varying positions of the centre of gravity of the Solar System in Space, some definite resultant might be found, shewing the direction in which it is travelling.

G. R. GIBBS.

Bournemouth.

ASTRONOMY.

To the Editors of "Knowledge."

Sirs,—I believe I am right in saying that while some account for the origin of the moon by saying that it at one time formed part of the earth, an offshoot from the earth, and so on, others explain it as being an old planet.

The reasoning for this latter explanation seems to be that a body goes through the following processes: First, the sun; second, the sun cooled and become a planet, fit for the abode of living creatures; third, the planet cooled and become a moon, a dead world.

To take as an example the sun and the earth. The supposition would be that the earth was previously a sun, but had now cooled and become a planet. As the sun gets cooler, so, naturally, will the earth, until the latter eventually reaches the phase of a moon.

It seems to be rather on these lines that Mr. Proctor bases his theory of Jupiter's moons being inhabited (*vide* "Expanse of Heaven"), Jupiter being put forward as a sort of sun, with his moons really planets (Jupiter in this way might be regarded as illustrating the half way stage in the evolution of a sun to a planet fit for living creatures).

At a lecture I attended not long ago the lecturer happened to mention the theory of the moon being an offshoot from the earth, and at the close of the lecture I mentioned the other theory (just described), and asked him which of the two was the more universally accepted. He seemed never to have heard of the second theory at all.

Can you tell me which of these two theories finds most support from astronomers of to-day?

"INQUIRER."

Catford, S.E.

ON THE ROTATION OF VENUS.

To the Editors of "Knowledge."

Sirs,—I write this letter in answer to the doubts expressed by your correspondent, Mr. Harrison, in the hope that my reply may be of general interest to your readers.

Mr. Harrison first contrasts the conclusions of Belopolsky and Slipher as to their spectroscopic evidence.

It is to me amply evident that in this matter Slipher's conclusions are the stronger, founded as they are on photographs taken on a more favourable opportunity and with a more powerful spectroscope than that used by Belopolsky. It is a striking fact that Slipher's results indicate no rotation at all—for the final mean radial velocities deduced are conflicting in sign, and either practically equal to or less than the probable errors of observation. The evidence is therefore negative.

Referring to the Lowell Observatory Bulletins Nos. 3 and 4, I find the following statements:—

"A rotation period of twenty-four hours would in the case of Venus imply an inclination of 15′ to the normal in the planetary lines. The probable errors of determination of the inclination of the lines are, in the case of Venus, somewhat less than 1′ in the final result."

"When Mars' spectrum was measured to test the method—an inclination of 6′·6 was found—indicating a period of revolution within an hour of the known one." (These quotations are not verbatim but condensed.)

It is then apparent that had Venus any such period the latter could be determined with more than double the accuracy possible in the case of Mars. It is thus clear that Venus' period is much longer than that of the Earth.

Now for positive evidence as to how much longer the period may be, visual observations are our only resource; and thanks to the purifying influence of modern research, that source is now reliable. I have myself been able to corroborate the markings seen by Schiaparelli, Lowell and others, and I am convinced not only of their reality on the planet, but of their fixity with regard to the terminator. They indicate without question that the planet turns always the same face to the Sun.

The observations of Schroeter and De Vico, quoted by Mr. Harrison, were interpreted by them to indicate a period about equal to that of the Earth. It is absurd to suppose that they could also support such a period and also a period half as long again. To do this all the planetary markings would have to be in two places at once—in his eye and his telescope perhaps they appeared to be—but on the planet never. If the markings charted by the older observers were real they should be easily visible in the vastly better telescopes of the present day. In ordinary air—the better the telescope the more immaculate the planet appears. It is only under very favourable climatic conditions that the observer can be assured of their reality. They are harder to see than the canals of Mars. It is therefore foolish to quote the early observers, whose evidence in the light of modern research is thus proved to be valueless, for they never saw canals on Mars. Nevertheless to them is owing the credit of opening the question. The radial markings discovered by Lowell are just those to be expected on a planet which is like a cryophorus: a planet which has one side permanently heated—and consequently having an inward and upward fountain circulation of atmosphere.

Again, G. H. Darwin's "Tidal Theory" suggests the reason for and the probability of Venus always turning the same face to the Sun—which probability is increased by the likelihood that Venus never revolved as fast as the earth did at the time of the birth of the Moon. For Venus has no large satellite. Hence she was never disrupted by the tidal action of the Sun operating in conjunction with centrifugal force, due to very rapid rotation. Yet, since solar tides on Venus are much more potent than on the earth, this disruption is *a priori* the more likely. If, then, Venus never rotated as fast as the Earth once did, she would the more quickly have been stopped by these same tides; and having no large satellite, there is no other attractive force to oppose that of the Sun. To sum up, every piece of reliable evidence we have been able to adduce points to a rotation period of two hundred and twenty-five days. There is not a shred of conflicting testimony. There seems to me to be no reason whatever for hesitating further to accept the indicated conclusion that the orbital and rotational periods of Venus are identical.

JAMES H. WORTHINGTON.

LOWELL OBSERVATORY,
FLAGSTAFF, A.T.

ORNITHOLOGY.

To the Editors of "KNOWLEDGE."

SIRS,—In "KNOWLEDGE" for December, I noticed that a correspondent wrote regarding the starling as a mimic; I write an article headed—"Does the starling relieve sheep of ticks?"

On grounds where sheep are grazing, especially if such grounds be somewhat boggy, starlings are seen perched upon the backs of sheep. Starlings are said to visit sheep in order to feed on the ticks which infest the sheep. After close, patient watching I could never see the starlings pick into the wool on the back of the sheep for ticks. I am inclined to think that the starlings visit sheep because they find their backs comfortable and handy. Then these birds seem to be of a very friendly nature to animals they are accustomed to feed amongst. An article in "Nature Notes" of the *Scotsman* recently showed the social nature of this bird in captivity with a cat, "Starling and Kitten." The bird is seen perched upon the back of the cat. Sometimes the starling was found keeping up this position for half-an-hour.

EDGAR GRANT.

EDINBURGH.

THE VELOCITY OF LIGHT.

To the Editors of "KNOWLEDGE."

SIRS,—I am a little disappointed to find that Colonel Gibbs was not facetious in his suggestion as to the velocity of light.

May I point out that his error is based on his fundamental fallacy that the eye "is not capable of seeing anything that passes across its field of vision in less than a tenth of a second." This may or may not be true of some objects—such as a bullet—but it is absurd to suppose it true of a luminous object.

CHARLES E. BENHAM.

COLCHESTER.

THUNDERSTORMS.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Chamberlayne asks in your issue of January last:—"Inasmuch as the world is round and thunderstorms like everything else have a beginning, it follows that the first flash of lightning in any storm must be directly over somebody's head. How is it then that we cannot meet with anyone who remembers anything of the sort?"

My estimate based on observations here would be that out of one hundred thunderstorms one breaks almost exactly overhead. A remarkable case occurred here about six weeks ago; remarkable because the discharge came to the ground, which is unusual at the very beginning of a storm; and it was so heavy that it injured telephones.

TRANSVAAL OBSERVATORY,
JOHANNESBURG.

R. T. A. INNES.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Chamberlayne's letter on "Thunderstorms" recalls an instance which I may offer as an answer to his question. One afternoon in the late spring of 1892, at Denver, Colorado, the sky clouded slowly, whilst the temperature remained rather high. At six o'clock the heavens were entirely covered, and half an hour later, without any preliminary electrical display, a brilliant flash of lightning rent the clouds, and was followed instantly by a heavy peal of thunder. In a few minutes rain began to fall. The storm, with its attendant electricity, lasted nearly an hour before moving away.

This is the only instance of the kind that I have particularly remarked. Here, on the coast of California, thunderstorms, even of a mild type, are infrequent, so there is little opportunity to make observations of their phenomena. Storms in the mountains are sometimes visible here, at a distance of from fifteen to twenty-five miles, and, as these are always local in character, the "first flash directly overhead" must often have been observed in them.

CHARLES C. CONROY,

LOS ANGELES,
CALIFORNIA.

NOTICES.

THE HORNIMAN MUSEUM.—The new Library at the Horniman Museum, which was recently opened to the public, will now be available on week days throughout the year, from 11.0 a.m. to 9.0 p.m., and on Sundays from 3.0 to 9.0 p.m. It will, however, be closed on Christmas Day, Good Friday and Bank Holidays.

FLAME CARBONS.—Messrs. William Gilbert and Company, have introduced improvements in their flame carbons, with the result that their business in this department, as in others, shows considerable increase upon that of 1910, or indeed of any year since they took over the business of Messrs. Paterson and Company.

THE KNOWLEDGE OF THE LIVING NAPOLEON DURING THE LAST PHASE [1815-1821].

By A. M. BROADLEY,

Author of "Napoleon in Caricature."

SINCE the beginning of the present year two books have been published which ought to throw some new light on the personality of Napoleon during the last five years of his eventful life. If the student is somewhat disappointed at the paucity of information of this particular kind contained in the superbly-printed pages of Monsieur Frédéric Masson's monumental work "Napoléon à St. Hélène," he will find some consolation in the lively pages of Mr. G. L. de St. M. Watson's "A Polish Exile with Napoleon"—a work based mainly on painstaking research in historical ground which may fairly be described as unbroken.

In the concluding volume of his great biography of the younger Pitt, entitled "Pitt and Napoleon Miscellanies," will be found a very interesting account of an interview with Napoleon which took place at Elba on the evening of January 26th, 1815. Four days previously two English travellers, Major I. H. Vivian and his companion, Mr. Wildman, had arrived at Porto Ferrajo from Leghorn. The interview they sought for was arranged through Count Bertrand, and at the appointed time they were, "without any form or ceremony whatever," ushered into the presence of the Great Man. Twenty-four years later Major Vivian printed, for private circulation only, the narrative now republished by Dr. Rose. We are told the room of modest dimensions in which Napoleon received his English guests was fitted up with old yellow furniture brought from the palace of his sister at Piombino. The conversation lasted from 8.30 to 9.45 p.m., and Major Vivian had a unique opportunity of studying the personal appearance of Napoleon as it was five months before Waterloo. He writes:—

"We stood, during the whole time, I may say almost *nez à nez*, for I had my back against the table, and he had advanced close to me, looking full in my face. . . . . He had on a green coat, cut off in front, faced with the same colour and trimmed with red at the skirts, and wore the stars of two orders. Under his left arm he held his hat, and in his hand a plain snuff-box, from which he every now and then took a pinch; but as he occasionally sneezed, it appeared to me that he was not addicted to snuff-taking. His hair was without powder and quite straight; his shape, inclined to corpulence."

FIGURE 157.
Napoleon on the "Bellerophon," after Eastlake's picture. 1815.

We have no present concern with the return from Elba, the Reign of a Hundred Days, or Waterloo. Suffice it to say that at sunrise on Saturday, July 15th (only eleven days short of six months since the interview with Vivian and Wildman in the "yellow" drawing-room of the Imperial Residence at Elba), Napoleon, wearing the uniform of a colonel of the *Chasseurs de la Garde*, went on board the "Bellerophon." Exactly a week later the ship arrived at Plymouth. On the following day (Sunday, July 23rd), the ship moved to Torbay, where she remained until the following Wednesday (July 26th). On that day the "Bellerophon" returned to Plymouth, and there on July 31st Napoleon learned his fate. Early in the afternoon of August 7th (Monday), the Emperor went on board the "Northumberland" at Starpoint. The same day she set sail for St. Helena. During the days spent at Torbay and Plymouth, Napoleon was seen by many thousands of persons. It is only quite lately that the last of those who looked on "Little Boney" face to face from the crowded boats cruising round the "Bellerophon" in July, 1815, expired. Twenty years ago a score of surviving witnesses were still able to testify to the approximate correctness of the familiar picture by Sir C. L. Eastlake, P.R.A., now reproduced as the first of the series of last phase portraits. (See Figure 157.)

Eastlake was a native of Plymouth, where he was born on November 17th, 1793. He was studying the masterpieces of the Louvre, when the news of Napoleon's landing caused him to quit Paris on March 19th, the same day as Louis the Well-Beloved took to flight. When the "Bellerophon" arrived in Plymouth Sound, Eastlake promptly postponed all the work he had on hand, and, "hovering round the ship" in a boat, took a series of rapid sketches of Napoleon as he stood in the gangway, from which he elaborated a small full-length portrait of the Emperor, and another life-size. The latter was subsequently exhibited in London. The fine mezzotint executed from it by C. Turner, is familiar to most collectors, but when used as an illustration by the present writer, an art critic declared that the picture represented Napoleon at Malmaison, and that the rolled-up hammocks and other accessories belonged to a garden instead of a ship! The Turner mezzotint, of which an exceptionally fine example in the second state is now in the possession of Mr. Henry Parker, of Whitcombe Street, bears the following inscription:—

"Napoleon Boneparte as he presented himself at the gangway of His Majesty's Ship "Bellerophon," in Plymouth Sound, in the month of August, 1815. To His Royal Highness the Prince Regent this print, as commemorating the result of the persevering resistance of Great Britain to the ambition of Napoleon, and as exhibiting one of the immediate and most important consequences of the Victory of Waterloo, Is, with His Royal Highness's permission, humbly and respectfully dedicated by His Royal Highness's faithful, devoted servant, Charles Lock Eastlake. London, Published August 26, 1816, by C. Turner, 50, Warren Street, Fitzroy Square."

Mr. Denzil Ibbetson,' of the Commissariat Department, sailed in the "Northumberland," and between Monday, August 7th, when the ship left the Sound, and Tuesday, October 17th, when Napoleon disembarked at Jamestown, executed the various portraits described in the current issue of *The Century Magazine*, the majority of which were unknown and unidentified until discovered by the present writer. It was most probably from one of these that Mr. Williams prepared the print issued by T. Patser, on January 14th, 1816, now given as an illustration. (See Figure 158.) This was certainly one of the first portraits of Napoleon published in Europe after his arrival at St. Helena. The figure of the Emperor bears a strong resemblance to that introduced into Major Stewart's view of the "Briars" which appeared in the last issue of "KNOWLEDGE." (See page 100.)

Early in 1904, a letter addressed by Sir Stamford Raffles to Mr. Sholto V. Hare, came into the possession of the writer. It is dated "Off St. Helena, May 20th, 1816," and covers no less than twenty-four quarto sheets. It gives a most detailed account of an interview which our Minister in Java had had with Napoleon at Longwood, a day or two before. The visit of Sir Stamford Raffles is not mentioned by M. Albert Schuermans in his "Itinéraire Général." He notes that it was on May 16th, Sir Hudson Lowe communicated to the Emperor the Convention of Paris, of August 2nd. On May 17th, Napoleon was working on the events of 18 Brumaire and the Egyptian Campaign. On May 19th he was making notes on the events of 1815.

The personality of Napoleon in May, 1816, did not impress Sir Stamford Raffles as favourably as it did Major Vivian

FIGURE 158.

Napoleon on the "Northumberland," from an aquatint by Williams, published by Thomas Parker, January 14th, 1816, presumably from one of Denzil Ibbetson's sketches.

FIGURE 159.

Napoleon. Portrait forming the frontispiece to Barnes's "Tour through the Island of St. Helena."

and Mr. W[illegible] in [illegible] 181[illegible]. He [illegible] [illegible] [illegible]

FIGURE 160.
Napoleon. From a sketch made in April, 1820.

man, moving with a very awkward gait, and reminding us of a citizen lounging in the tea gardens about London on a Sunday afternoon. He was dressed in a large, but plain, cocked hat, a dark green hunting coat, with a star, etc., on the left breast, white kerseymere breeches and white silk stockings."

In another part of the letter he writes:—

"Bonaparte must either be very different in his present appearance and demeanour to what he once was, or we have all been in a great measure deceived. In person he is more like old Wardemaat, of Batavia, than any man I can name. This resemblance struck us all. To be sure, he has not quite so large a belly, but in other points he does not fall short in size. His face is square, his colour sallow, and his eyes rounded without reflecting one ray of light. His visage generally was not unlike that of a Brazilian Portuguese. Though still deficient in animation, his manner was abrupt, rude and authoritative, and the most ungentlemanly that I ever witnessed. While speaking he took snuff or seemed to take it, for there was none in his box, and altogether treated us in the same manner as in his worst humour he was wont to do."

Captain John Barnes's "Tour through the Island of St. Helena" was published in London a year after the Raffles visit. The coloured frontispiece "Napoleon Buonaparte on the Island of St. Helena" is here reproduced. It must, for obvious reasons, have been engraved by R. B. Peake from a sketch of [illegible] to, and does not in any case show the determination spoken of so unflatteringly by Sir Stamford Raffles, who declared he came to Longwood with a predisposition in favour of the illustrious exile. There is no description of Napoleon to be found in Captain Barnes's commonplace text, but amongst the subscribers to the work are Lieut.-Col. Dodgin, C.B., Lieut. Dodgin and Ensign Dodgin, all of the 66th Regiment. Lieutenant (afterwards Captain) Dodgin, as Mr. Watson points out, is responsible for the portrait of Napoleon executed in 1820, now given. (See Figure 160.) Another of Barnes's subscribers was Mr. Denzil Ibbetson.

The only uniform Napoleon ever put on at St. Helena was that of the Chasseurs de la Garde, the green coat with red facings, white breeches and top-boots, shewn in the Barnes frontispiece; but on November 28th, 1815, he dropped the uniform (only to be resumed on special occasions, such as his move to Longwood on December 10th, 1815), and put on a cut-away tail-coat, brown or green, with white breeches and silk hose, a small hat with tricolour cockade and the *plaque* and ribbon of the Legion of Honour. The green coat was an old hunting

FIGURE 161.
Napoleon as portrayed by Captain Dodgin of the 66th Regiment in 1820.

costume of the Fontainebleau period and was turned by Santini when it got very shabby. The cockade was dropped in June, 1817. After Santini's departure, tailors from Jamestown and the British regiments made various articles of dress for Longwood, but nothing specially for Napoleon, except the "planter's" costume. It is to Mr. Watson that we are indebted for a knowledge of Captain Nicholls's journal, in which, with "sartorial correctitude," he describes the grotesque appearance of the General (the use of the word Emperor was strictly forbidden), in "his nankeen jacket, waiscoat and *trowsers* and a straw hat." The Duke of Wellington is credited with having invented trowsers about 1810. The Bath militiamen threatened a mutiny in defence of the doomed knee-breeches, and Oxford and Cambridge undergraduates who adopted the new garments incurred grave censure on the part of the outraged authorities. We see the "planter's" garb in the horrible portrait entitled "Napoleon at St. Helena in the second year of Cancer of the Stomach" issued by Standridge & Co., London, early in 1821. Below the cynical artist or publisher has placed the lines:

"I never had for *abstract* fame much passion,
But would much rather have a sound digestion
Than Buonaparte's cancer could I dash on
Through fifty victories to shame or fame,
Without a stomach—what were a great name?"

FIGURE 162.

Anonymous caricature portrait, June 5th, 1820.

Mr. Watson says that this dress was adopted in 1820, but it does not appear, at any rate in its entirety, in the portrait entitled "*Fleshy* ci-devant *Bony* Drawn from the life at Longwood, June 5th,

FIGURE 163.

Napoleon. Caricature portrait early in 1821.

1820." (See Figure 162.) It is altogether absent in the Dodgin portrait of the same year (see Figure 161), but it is clearly shewn in a third 1820 portrait in the collection of the writer. (See Figure 163.) Archembault replaced Santini as tailor, and Captain Lutyens in his journal speaks of a tailor of the 66th regiment being hard at work with him. Mr. Watson informed the writer that "the only overcoat the Emperor used was a little grey one, as on the field of battle. The 'cloak of Marengo' was religiously kept by Marchand, and used only for the last function after death. On the opening of the coffin in 1840, it was found in fair condition, as well as the Chasseur's uniform. The epaulets had tarnished, but the central head of the Legion of Honour *plaque* was still bright. The boots had split and the toes protruded." This last is clearly seen in the illustration, Figure 104, in the last issue of this journal.

When Napoleon landed at St. Helena at the end of 1815 he was already sallow and corpulent. No great change occurred in 1816 or 1817, but later he put on more flesh, and we have the pronounced double chin and flaccid face reflected in the Dodgin portrait now given. The gardening exercise failed to combat the constant increase of adiposity which called forth Doveton's coarse, yet truthful, epithet "plump as a Chinese pig." He suffered much from bad teeth and swollen gums, and early in 1820 his eyesight began to fail. From this time onwards he could not read without immediate fatigue and strain. During his last illness he lost some of the fat which had given him the protuberant abdomen which Dodgin made the most of, but at the post-mortem dissection Antommarchi had to cut through three-quarters of an inch of subcutaneous fat before reaching the viscera. Immediately after death the fat under the skin of the face, as Ibbetson noticed, dried up and the cheeks sank a little. When friends and foes stood round his death-bed on May 6th, the dead Napoleon had once again the finely-chiselled features of the First Consul. With one accord they said: "How beautiful!"

CUTTING DOWN A CHIMNEY LIKE A TREE.

By FRANK C. PERKINS.

The accompanying illustration, Figure 164, shows a chimney ready to be thrown like a tree, while Figure 165, shows the stack when falling to the ground. This stack was ten feet square at the base, and a hundred feet high, and was built of common brick, lined with fire brick, and topped out with a cast iron cap.

It will be seen that the method of throwing this stack was quite similar to the cutting down of a large tree. Brickwork on the south side of the stack was cut out, extreme care being taken to make the cut symmetrical on each side of the centre line of the stack.

The first illustration (see Figure 164), shows quite clearly this method of cutting, which was continued until the weight of the stack began to crush the brickwork at the edge of the cutting, and as soon as this occurred the stack, of course, fell to the south.

It is stated that, so accurately was the work done, the fallen stack lay exactly parallel with the sidewalk, as was intended. The outer shell of the stack crushed downward, while the inner lining maintained its original shape until the falling stack struck the ground.

It is of interest to note that the stack was originally part of the Brush electric plant in Cleveland, Ohio, the site of which is now occupied by some of the factories of the National Electric Lamp Association. It was used in connection with the japanning process, and the stack was removed in order to make room for a large new incandescent lamp factory.

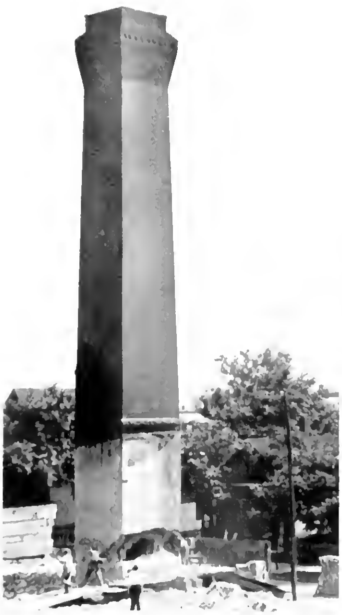


Figure 164.

Figure 165.

THE SWEDISH SYSTEM OF EDUCATIONAL AND MEDICAL GYMNASTICS.

By RHODA ANSTEY.

Principal of Anstey College for Physical Training and Hygiene, Erdington.

THE attention now being given to hygiene and physical culture is a very hopeful sign of the times. Mr. Gladstone once said that all the time and money spent on training the body and the voice paid a better interest than any other investment. A sound body is needful to all; it is well that English people are waking to this fact, and that there is such a wide-spread desire to improve the nation's physique.

The Swedish system of physical training which is found to produce such excellent results in the hands of trained teachers, represents the lifework of Per Henrik Ling, a man of remarkable genius, born in Sweden in the year 1776.

The fundamental principle of Ling's System is

FIGURE 166. Arch Flexion.

the harmonious development of mind and body, the mind to be dominant, the body obedient.

Ling taught that right thinking and a right direction of physical strength was of primary importance. The following episode in his life, narrated by an eye witness, is given by Westerblad, in his book on the Life and Work of Ling. "Ling once delivered a lecture in which he said that great strength, even the greatest, if badly used is nothing when compared to a little strength well used. At these words an auditor exclaimed, "Your theory is excellent, and I realise its correctness; will you oblige us by giving a practical proof of it?"

FIGURE 167. Heaving Movement.

"At this request Ling hesitated for an instant. But after a moment's consideration he answered, 'I will prove the truth of my words.' 'Will you bring me a long lance?' he continued, addressing those present. They brought him what he asked for. 'We'll make an experiment with this lance,' he said. 'Which of you are the strongest? Six of you come forward, please. Seize the end of the lance, please.' Ling went on 'You are six young men and you have at your disposal a capital lance with a head as sharp as the blade of a sword. Nevertheless, I bid you attack me, and to run me through with the lance without mercy if you are able to do it, you see. I promise not to budge from the spot. When I give the word of command, you may advance. The lance-head thrust towards my breast.' Well, are you ready?

"At the [illegible] Ling [illegible] in repose. He

FIGURE 108. Balancing.

positively increased in height, while his eyes beamed with fire and life. He gave the word 'Go' and the six young men rushed forward. Ling did not move from the spot, but fixed his eyes sharply on the lance-head and lifted his hand towards his breast. Just as the lance-head was at a distance of a few inches he parried the thrust with his little finger, and the lance-head entered the wall at his side. A volley of applause rang through the hall." The truth of this story is vouched for by a pupil of his who was present.

Ling was well versed in the scientific knowledge of his day, but he also possessed a profound intuitive understanding of the laws of the human organism. His system is based on knowledge of anatomical, physiological and psychological laws which were not fully known to science at that time. After a hundred years his theories have received their justification, both from scientific research and practical experience.

Ling's system was evolved upon a therapeutic basis. He was first attracted to the idea of systematic exercise by observing the curative effect on himself. But he was not satisfied to regard these exercises as a mere vehicle for physical health, he maintained that gymnastics had a higher significance, and placed them among the arts and sciences. He gave out these new ideas and insisted on the importance of a common national regeneration, a regeneration of Swedish manhood, and of Swedish poetry. The remedies he proposed in ardent speeches were a return to gymnastic exercises, and a revival of old Scandinavian poetry. These were met with scornful opposition at first, the daily papers commented on them in most flippant terms, designating him as a "charlatan" and a "gymnastic harlequin." People trifled with his ideas and laughed at his innovations, but the innovations increased instead of diminishing, while he fought for his ideals with intense enthusiasm and power.

Ling believed that if gymnastic training could become a national aim and a national ambition, it would be possible to produce health, strength and beauty in youth, to conserve them through adult life, and prolong them during old age. Also that it was possible by systematic exercises to correct many imperfections in the body and cause certain functional derangements to yield to this most natural method of cure, provided each exercise had a definite physiological aim and produced a definite physiological result. He then conceived the idea that an extensive, graduated series of movements

FIGURE 109. Shoulder Movement.

could be devised, suitable for every stage, from weakness up to the greatest strength, adaptable alike to the requirements of little children, to girls as well as boys, to women as well as men, and again to the use of those who even in advanced age might wish to derive the benefits conferred by exercises. The fulfilment of this idea became the object of his life. In time all opposition was broken down, and he succeeded in founding a Gymnastic Institute in Stockholm, with Government aid, and he became its first Director.

For many years Ling worked patiently and earnestly, studying natural science, making himself conversant with the human body in all conditions of health and disease, of weakness and of strength; learning and realizing its possibilities and its limitations. He studied the Greek art of gymnastics, and the different forms of athletics and gymnastics of modern times. He evolved great principles, was entirely guided by them, and rejected all exercises which did not come up to their high standard. With a stern hand he put aside all movements for *effect*, and weeded out the injurious elements of competition and excitement. He made close and practical experiment of the effects of different kinds of exercises on the physique in various states, and finally produced an elaborate series of pure, simple and beautiful movements, each having its own aim and producing its own result. Then, with a master hand, he drew

FIGURE 170. Abdominal Movements.

up into form and completed his work—a work which has since obtained a unique position as a classical system of physical education.

Ling's system is divided into four branches, which intertwine to some extent.

Educational.—Comprises both [illegible]

FIGURE 171. [illegible] Lesson.

exercises for schools and classes, designed to develop the entire physique harmoniously, and to quicken and cultivate the mental faculties.

Medical.—Used only for curative and preventive purposes, extensively supplemented by massage.

Military.—For the full training of soldiers. The Swedish system has recently been introduced at Aldershot, and into the English Navy.

Aesthetic.—To express by pose and gesture every kind of emotion. Swedish gymnastics is a *system*, and in this fact lies much of its value. The human body being a highly organised system, demands an organised method of culture. The kernel of the Swedish system is (1) the arrangement of the exercises in each lesson; (2) the progression from the easy to the more difficult, lesson by lesson, as muscle and nerve powers increase. In the educational branch there are nine classes of movements. In every lesson, whether elementary or advanced, the same plan is used. It is found that gymnastic training built on this plan gives the best results, e.g., most progress is made in the shortest time by this method, one exercise preparing for, and leading up to another. The movements follow each other in the correct order, one or more from each class being

FIGURE 172. Jumping.

introduced. This is the plan originally evolved by Ling, and used by all properly trained teachers.

The nine classes of movements are arranged in the following order:

1. INTRODUCTORY EXERCISES. These consist of marching; movements of legs and arms; easy trunk and head movements; simple exercises used to gain muscular control and to prepare for those which follow. They quicken the circulation; prepare the body for special work; give the teacher an opportunity to correct faults of posture, and bring teacher and pupils into touch with each other, and both into the spirit of the work.

2. ARCH FLEXIONS (see Figure 169) consist of backward bendings of the trunk in the dorsal region, movements which have a special effect on the thorax: they contract the muscles of the back, straighten the dorsal spine, elevate the chest and correct its posture. The chest capacity is enlarged, and respiration increased by reaction. The immediate effect is to draw more air into the lungs and, therefore, to supply more oxygen to the muscles. This is absolutely necessary as a preparation for more difficult movements which follow, for without this increase of oxygen they either could not be well done or might cause strain. There is permanent enlargement of the thorax and elevation of all the organs contained in the thorax and abdomen. This produces

FIGURE 173. Alighting from a Jump.

a smarter and more upright carriage, a graceful walk and increased power of the organs of digestion.

3. HEAVING MOVEMENTS exercise and develop the arm and shoulder muscles. They include all suspending (see Figure 167) and climbing exercises. They also prevent and correct faulty positions of the spine.

By constantly practising these two kinds of movements the chest enlarges both lengthwise and in breadth. It will be seen that the greatest attention is given to the development of the chest, for in order to be strong we must breathe deeply and well. Good breathing power means health, strength, endurance and longevity. This is why the Swedish method discards all movements which compress the chest.

4. BALANCE MOVEMENTS (see Figure 168) come after Heave movements because they equalise the circulation which has been directed to the chest. The pupil gets out of breath from climbing, and so on, and the heart beats more quickly: so we give here a movement which has a calming effect and lessens the heart beat.

Balance movements are general in effect, they do not need much muscular effort, but they require concentration of mind. Their special effect is on the nervous system, which they train and strengthen. Balance movements cultivate co-ordination, give consciousness of power, and a reposeful bearing: they teach correct poise, and enable the body to move gracefully and easily. After doing the balance movement the pupil is ready for more specific work.

5. SHOULDER (see Figure 169), BACK AND NECK MOVEMENTS strengthen the muscles of the back and neck, thereby giving the head and upper part of the body a more noble poise. They develop the brain, and increase skill of hand. They are also used to correct round shoulders and flat chest.

6. ABDOMINAL MOVEMENTS (see Figure 170) affect the digestion and assimilation of food. They have a good effect on both mind and body through improved nutrition. They develop the waist muscles, and thus give a trimness to the figure. They are used to correct hollow back and protruding abdomen.

7. LATERAL TRUNK MOVEMENTS (see Figure 171) consist of trunk rotation and sideway flexions. They accentuate the effect of the abdominal movements. They quicken the circulation of the large veins of the trunk and promote the activity of the liver. They strengthen the waist muscles and develop "Nature's corset." Nature has given us muscles with which to support the body in an upright position. Exercise strengthens these muscles, corsets weaken them.

8. JUMPING (see Figures 172 and 173) AND VAULTING develop courage, presence of mind and co-ordination. These exercises develop spring, and from their widespread effect and bracing nature exert an exhilarating influence on mind and body.

FIGURE 174. Inspiration.

FIGURE 175. Expiration.

Respiratory Exercises.

They [illegible] quickness of thought and action. As they need more control than any of the preceding they are placed at the end of the lesson, when control of body has been acquired.

9. Respiratory Exercises (see Figures 174 and 175). — Consist of deep inspirations and expirations for the purpose of increasing the supply of oxygen to the system. They are generally accompanied by some simple arm movements which open the chest. They lessen fatigue and give a sense of repose.

Thus every part of the body is scientifically trained and strengthened. The organs of respiration, circulation and digestion receive more attention than the muscular development, so that these storehouses of vitality may be replenished and the brain, nerves and muscles supplied with healthy nutriment.

The movements are executed at word of command in order to prevent mechanical work and involuntary imitation. It is an essential principle that each exercise should be completely and correctly carried out at the teacher's command, as the best results are obtained even in a simple movement by the concentration of the will on the exercise. Style and precision of movement and progress in details are aimed at rather than feats of strength.

The importance of having fully trained teachers as exponents of the Swedish system cannot be too much emphasised; much harm is being done by the ignorant and uninitiated, who attempt to teach so-called "Swedish Drill" after having learnt a few exercises. It must be remembered that while suitable exercises, properly performed, can and do correct faulty postures, unsuitable and even suitable ones incorrectly performed produce, and exaggerate, the very postures and deformities of the body for which they are meant to be corrective.

Unless a teacher is both trained and observant more harm than good is likely to be done by teaching gymnastics. As Dr. Shrubsell says: "No one would dream of placing a teacher who had never learned mathematics in charge of a mathematical class, where the worst that could happen would be failure to acquire knowledge, a purely negative result; whereas often untrained teachers are set to put a class through gymnastic exercises, with the grave risk of producing a permanent, positive result in the direction of bad carriage and even bodily deformity. Two years is none too long in which to learn both the principles of the subject and their application. Slight knowledge is almost more dangerous than none at all."

Swedish gymnastics should constitute a part of the ordinary school work, and a place should be given for daily lessons in the timetable. Being less recreative, and presenting a corrective element, they are not intended to take the place of games. They make considerable calls on the mental as well as the bodily activities, and to produce the best effects should be taken during morning school and not relegated to the last period of the afternoon.

It is instructive to notice that during the thirty years the Swedish system has been in general use in Scandinavian schools, the average stature and weight of the children have shown a marked increase.

NOTE. — We had the pleasure of going down to the Anstey College and seeing for ourselves the most interesting and successful work of the students there. Birmingham is only two hours' journey from Euston on the London and North-Western Railway, and a local train carries one on to Chester Road, Erdington, which is practically in the suburbs of the city. — EDS.

THE STUDY OF PRIMITIVE MUSIC.

DR. C. S. MYERS gave a lecture on "Primitive Music" at the Royal Anthropological Institute on Tuesday, March 19th, when the President, Mr. Alfred P. Maudslay, was in the chair.

In this paper the chief objects and methods of studying the music of primitive peoples were described, illustrated by examples from Borneo (Sarawak), Torres Straits (Murray Islanders) and Ceylon (Veddas), the music of which Dr. Myers had personally investigated. Many of the songs were exhibited by means of the phonograph, an instrument, the importance of which, even to the most musically-gifted ethnologist working "in the field," was strongly emphasized. The structure and details of other songs were indicated by various lantern slides in which (i) the music was reduced to our own notation; (ii) the nature and frequency of the various intervals employed were demonstrated, the intervals being expressed in ratios of vibration frequencies or in "cents," *i.e.*, hundredth parts of our tempered semitone, and (iii) the various scales deduced from the songs were shown. Detailed descriptions were given of the *technique* of analysing phonographic records and of the graphic method introduced by Dr. Myers for recording "in the field" the occasionally baffling rhythms met with especially in the drum accompaniments to primitive music. The music of the Murray Islanders and of the Todas was analysed to show (i) the wide difference even between such very simple forms of music belonging to two distant peoples; (ii) the different lines of musical development traceable within different communities; (iii) the great importance, alike for ethnology and for musical history, of studying the process of diffusion of the various styles of music, and also of musical instruments, in regard to their form, their intervals and their absolute pitch.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

I have decided to use my column this month to give an explanation of the Harvard system of classification of star-spectra, which is now in general use. As spectra are often quoted simply by their letters in this classification, and as the full description in *Harvard Annals*, Vol. XXVIII, is probably not readily accessible to many of our readers, it seems likely that it will be convenient to give a summary of it here.

The main classes of spectra are denoted by the letters O, B, A, F, G, K, M, N, which originally followed each other in alphabetical order (in the Draper Catalogue), but have now been put into the order which is conjectured to be the chronological order of their life-history. The fact, recently discovered by Professor Campbell, that average radial velocities increase as we pass from the beginning to the end of this set of letters, is a distinct confirmation of the theory that it is a true chronological sequence. Besides the above eight letters, P and Q are used, the former for gaseous nebulae, the latter for peculiar spectra having bright lines. Small letters following the capital ones, as Oa, Mb, and so on, indicate sub-divisions of main classes. Where two capitals are used with a numeral between, as B1A, B3A, B5A, the meaning is that the type is intermediate between B and A, and one-tenth, three-tenths, five-tenths respectively of the interval from the former to the latter type.

We now proceed to the description of the types. The letter O in general corresponds to Secchi's Fifth Type.

Oa.—There are no very bright stars of this type. The spectra consist of bright bands on a faint continuous background. Two of the bright bands are hydrogen ones, 4101·8 = Hδ, 4340·7 = Hγ. A fainter one at 4471·8 appears to be helium. There is a broad conspicuous band at 4633.

Ob.—There are no very bright stars of this type. Spectrum similar in general character to Oa, but positions and intensities of the bands differ. Several hydrogen lines bright, including Hε, Hδ, Hγ, Hβ; no helium lines seen. An intensely bright band has centre at 4688.

Oc.—No very bright stars of this type. The bands are much narrower than in Ob. Hδ, Hγ, Hβ, 4471·8 (helium) and 4688 are again bright.

Od.—Typical star ζ Puppis. All lines are dark except 4633 and 4688, which are bright. The dark lines are narrow. Hydrogen lines dark. Only four other dark lines.

Oe.—Typical star, 29 Canis Maj.; like Od, but far more dark lines.

Oe5B.—Typical stars, τ Can. Maj., and ε Orionis. No bright bands. Resemble Oe in hydrogen spectrum, B in helium spectrum. K (calcium) sharply defined.

B.—This is sometimes known as the "Helium" or "Orion" type. Typical stars, ε, ζ, δ Orionis. Helium lines more conspicuous than hydrogen ones.

B1A.—Type, β Centauri. More faint lines than in B. Helium lines intense, including D₃.

B2A.—Type, γ Orionis. The helium lines attain their maximum intensity in this class.

B3A.—Types, α Pavonis, π⁴ Orionis. Diminution in strength of "Orion" lines.

B5A.—Type, η Tauri (Alcyone). Helium still present, but less conspicuous; hydrogen, calcium, and so on, more conspicuous.

B8A.—Type, γ Gruis. Hydrogen lines still increasing in intensity, and are hazy; twelve "Orion" lines still seen. The solar lines seen in Class A now begin to appear.

B9A.—Type, λ Centauri. Spectrum like A class, with addition of helium.

A (Sirian stars).—Types, Sirius and Vega. Secchi's First Type. Hydrogen lines attain their maximum strength in this and in the next class. Calcium fairly conspicuous, and there are ninety-three solar lines.

A2F. Type, γ Centauri. Calcium and solar lines are stronger than in last.

A3F. Type, α [illegible]. Calcium more intense, solar lines more numerous and more intense.

A5F. Type, [illegible]. Hydrogen begins to weaken; [illegible] lines continue to increase. All lines somewhat [illegible]

F. Type, [illegible]. This class is intermediate between Secchi's first and second types. Hydrogen only half as intense as in A. Ultra-violet spectrum strong. Two hundred and twenty-six solar lines present.

F2G. Type, π Sagittarii. The G band in the spectrum grows stronger.

F5G. Type, Procyon. Hydrogen, though only half as intense as in Sirius, is still two or three times as intense as in Sun, while solar lines are fainter and fewer than in Sun.

F8G. Type, α Fornacis. Resembles following class, except that hydrogen is twice as intense.

G (solar stars). Secchi's second type. Type Capella. Hydrogen one-fifth as intense as in Sirius. The calcium H,K lines, and the band G are the most conspicuous features.

G5K. Types, α Reticuli and β Corvi. Hydrogen still grows weaker, and absorption at violet end begins.

K. Intermediate between Secchi's second and third types. Types α Phoenicis and ε Scorpii. Hydrogen one-twelfth as intense as in Sirius. The K line of calcium attains its maximum intensity in this and the next class. There are brightish bands whose limits are 4470 to 4525, 4613 to 4648 in this and preceding class. Arcturus belongs to this class; its spectrum resembles that of a sun-spot, so that it is probably much more spotted than the Sun.

K2M. Type, α Librae. Like following class in intensities of solar lines and absorption at violet end. But the G band is still continuous as in Class K.

K5M.—Type, Aldebaran. Like Secchi's Third Type. Hydrogen lines one-twentieth as intense as in Sirius, and are inconspicuous among solar lines. The spectrum beyond K too faint to photograph. H,K are conspicuous. The G band is broken up into lines with bright intervals. There are the same brightish bands as in Class K and some others.

Ma. Types, Betelgeux and γ Hydri. This is Secchi's Third Type. Spectrum banded. There are now well marked bands from 4762 to 4954, and 4954 to 5168, which were faintly seen in K5M. "The edges 4762, 4954, 5168 are brighter than the adjacent continuous spectrum, and the change in intensity from these edges towards the end of greater wavelength is abrupt." There are bright bands, 4470 to 4525, 4550 to 4586, 4657 to 4668. Hydrogen lines similar to Aldebaran. The H,K bands are barely seen. The lines that formed the band G in Classes G to K are now well separated.

Antares is of Class Ma except that hydrogen lines Hβ, Hγ, Hδ are stronger, and Hη, Hε are present as in Class A. Betelgeux has also stronger hydrogen lines than the normal Ma star.

Mb. Typical stars, γ Crucis, σ Librae. The abrupt change of light from the edges of the bands towards the end of the spectrum of greater wave-length is more marked than in Ma. Numerous bands brighter than adjacent portions of the spectrum are present. Hydrogen even fainter than Ma, and is only one-thirtieth as intense as in Sirius. Line 4227 reaches its maximum intensity in this class.

Md.—This class resembles Mb, except that Hδ, Hγ, Hβ (hydrogen lines) are bright. The lines of the band G are even less conspicuous than in Class Mb. ο Ceti (Mira) is of this class.

N.—This corresponds to Secchi's Fourth Type. It consists of small red stars with banded spectra, the bands being sharply defined at the red end and fading away gradually at the blue end (the opposite to the Third Type). The bands are due to carbon and cyanogen; those of the Third Type have been identified by Fowler with titanium oxide.

It will be remembered that Mr. Eddington recently pointed out that the M stars are intrinsically faint, having strongly absorbing atmospheres; consequently, they cannot be seen at a distance. This is the reason why the Sun's nearer neighbours contain an apparently undue proportion of M stars; they are probably really as common in the more distant parts of space, but too faint for us to see. Conversely the B stars are all very distant, and are probably actually rare in space, but being of great intrinsic brilliance they are seen at immense distances, and so appear in exaggerated numbers in our catalogues. The Sirian type of spectrum of Galactic stars would also be explained by stars of the solar type being invisible at such a great distance.

A NEW STAR.—A new star of the fourth magnitude was discovered at Kiel on March 13th. It is stated to be near Eta Geminorum (the same region where Professor Turner's Nova appeared in March, 1903).

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

POTASSIUM IN PLANTS.—Some interesting results bearing upon the localisation and function of the element potassium in plants have recently been published by Weevers (*Rec. Trav. Néerland.*, VIII., 1911), who made numerous tests by means of Macallum's method for the detection of potassium—the precipitation of potassium-cobalt-nitrite and the conversion of this into the black sulphide of cobalt by treatment with ammonium sulphide.

Weevers found potassium in the tissues of all the plants he examined, covering a wide range, excepting in the blue-green algae (Cyanophyceae) which gave negative results. In no case, however, was potassium to be found in the nucleus, even when abundant in the protoplasm of the cells. Even more surprising, in view of the statements of previous writers, was the entire absence of this element from chlorophyll and from the chromatophores themselves. The greater portion of the potassium was found in the cell sap vacuoles. In every case the potassium was present in a form soluble in water, and it could be extracted by means of water or dilute alcohol, but was insoluble in ether. In the flowering plants, this element is most abundant in the ground tissue (parenchyma), especially in the growing-points and in reserve food organs. It is also present in the living parenchyma of the wood and bark of trees, and particularly so in the growing layer (cambium) and in the medullary rays, which appear to serve as storeplaces of potassium for the growth of new shoots.

As to the functions of potassium, Weevers concludes from his observations that this element plays little or no part in the process of carbon assimilation, but is probably concerned in the building-up of protoplasm at the growing-points and in growing tissues generally. In the leaves, it probably helps in the synthesis and also in the breaking down of proteins.

BIOLOGY OF LICHENS.—An interesting paper by Tobler on the mode of nutrition of lichens was noted some time ago in these columns ("KNOWLEDGE," 1911, page 276). The same writer (*Jahrb. fur wiss. Bot.*, 1911) has since published a longer paper—the first instalment of what promises to be an important series of researches—in which he deals with the relation of two so-called "lichen parasites," both belonging to the Peziza family of fungi, to (1) the lichen host itself, to (2) the alga component of the lichen, and to (3) the substratum on which the lichen grows.

The fungus *Phacopsis vulpina* grows on the lichen *Evernia vulpina*, an alpine species. Tobler sectioned the fungus and lichen together in paraffin, and traced the course of the *Phacopsis* hyphae in the lichen thallus. These threads reach the enclosed alga cells and grow closely around these. Where the *Phacopsis* is best developed on the lichen, the alga cells are entirely absent; on other regions the algae are surrounded singly or in groups by the *Phacopsis* threads; in other places the hyphae of both *Phacopsis* and the lichen-fungus are found entwining the algae. Hence the *Phacopsis* threads can in time reach the algae in certain areas of the lichen thallus and displace the threads of the lichen fungus itself. The algae apparently multiply more rapidly for some time after the *Phacopsis* threads reach them, but they finally disappear entirely where these threads are most profusely developed. The *Phacopsis* threads then spread laterally until large portions of the *Evernia* cortex are cut off from the central tissue (medulla) and eventually die, the invading threads then penetrating into the dead cortex and also into the medulla of the lichen. Tobler concludes that the *Phacopsis* is at first a "parasymbiont," living in partnership with the lichen and later becomes parasitic.

The second parasite investigated, *Karschia destructans*, grows on the thallus of *Chaenotheca chrysocephala*, a bark-inhabiting lichen with thin crustaceous thallus. The *Karschia* penetrates into and through the lichen thallus and into the bark itself, on its way entwining and destroying alga cells and displacing and destroying the hyphae of the lichen. Finally, however, the *Karschia* threads enter the bark and then produces its spore fruits. Hence *Karschia* is successively a parasymbiont, a parasite, and finally a saprophyte.

From his study of these two fungi, out of about four hundred known to grow on lichens, Tobler concludes that there is no sharp distinction between parasites, parasymbionts, and saprophytes among these lichen-infesting fungi, since a single species may exist in all three conditions during its life history. He also claims that his researches break down the supposed sharp boundary between lichens and fungi, and his interesting observations certainly appear to support the view that the biological distinction between lichen-fungi and other fungi cannot serve any longer to maintain the lichens as a separate group of plants. That is to say, followed to their logical conclusion, Tobler's results lead us to the view that the fungus alone constitutes the lichen.

THE BUCKWHEAT SEED.—In many text-books the seed of Buckwheat, so commonly used as a type for germination in elementary botanical teaching, is said to contain perisperm, *i.e.*, nutritive tissue derived from the nucellus tissue lying outside of the embryo-sac and within the integument of the ovule, and this character has been regarded as an indication of affinity between the buckwheat family (Polygonaceae) and the Pepper family (Piperaceae). Stevens (*Bot. Gaz.*, 1912) has made a careful study of the development and structure of the Buckwheat seed, and finds that it contains no perisperm at all. The early development of the embryo agrees closely with that of the familiar and often-figured Shepherd's Purse (*Capsella*), and accompanying the growth of the embryo there is rapid development of endosperm from the contents of the embryo-sac. The nucellus is at an early stage present as a thin, but actively-growing layer, just within the integument, but as the seed matures this incipient perisperm is obliterated and in the ripe seed it is represented only by crushed remains of cells.

ANTS AND PLANTS.—An interesting paper on this subject has recently been published by Ridley (*Ann. Bot.*), who, as director of the botanical gardens at Singapore, has had exceptional facilities for the study of the myrmecophilous plants of the eastern Tropics. The cases of symbiosis between ants and plants dealt with in this paper fall into three categories.

Many such plants (e.g., *Dischidia rafflesiana* and several Rattans) afford shelter to ants, either within the leaves and flowers or in special hollowed out organs such as tubular stems or thorns, but the ants get no food from the plant, nor do they appear to benefit the latter, except that in a few cases the ants may bring about pollination when they nestle in and about the flowers, e.g., in *Goniothalamus ridleyi*.

In a second class of myrmecophilous plants there appears to be a relationship, which is mutually advantageous, between many epiphytic ferns and orchids, whose roots afford shelter, and the ants, which in making their nests bring up large quantities of soil and heap it round the base of the plants, e.g., *Thamnopteris nidus-avis*, *Platycerium biforme*, and a considerable number of orchids.

A third class of two small trees, *Macaranga triloba* and *M. griffithiana*, whose hollow stems are pierced and tenanted by ants. These trees have persistent stipules which have glands secreting waxy granules, these being gathered and used as food by the ants. In return for this food and shelter, the ants protect the trees from the attacks of larvae.

ALCOHOLIC FERMENTATION.—Some interesting results have recently been obtained from further work upon the fermentation of sugars by means of yeast. Harden and Norris (*Proc. Roy. Soc.*, B 82) have found that many yeasts that do not ferment the sugar galactose acquire the property of doing so after being cultivated for a time on a medium containing this sugar. They also find that the juice expressed from such a yeast is capable of fermenting galactose, and that the addition of phosphates to the fermentation mixture causes an acceleration of fermentation similar to that observed in mixtures of glucose, fructose, or mannose and yeast juice on the addition of phosphates. In each case, the phosphate is present in the form of an organic compound, from which it is not precipitated by magnesium citrate. Small quantities of sodium arsenite also accelerated fermentation.

As to the nature of the compound formed when a phosphate is added to a fermenting mixture of yeast juice and sugar, different workers have held that (1) the compound is a hexose phosphate containing two phosphoric acid residues; (2) it contains only one phosphoric acid residue, since the osazone obtained from it has only one such residue; (3) it is a triose phosphate. In a recent paper dealing with the mechanism of fermentation, Young (*Biochem. Zeitschr.*, 1911) brings forward evidence to show that the compound is a hexose phosphate with two acid residues, this contention being based largely on the composition of the barium salt of the compound and on the behaviour of its osazone.

Neuberg and Tir (*Biochem. Zeitschr.*, 1911) have greatly extended our knowledge of the action of yeasts upon substances other than sugars. The chief substances which are fermented in this way, with the evolution of carbon dioxide, are the common plant acids occurring in fruit juices, also various components or products of the yeast-cell, e.g., fatty acids, glycerine, and lecithin.

CHEMISTRY.

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

BACTERIAL DECOMPOSITION OF ARSENIC COMPOUNDS.—Arsenic is usually regarded as a powerful antiseptic agent—so much so that it will preserve organic tissues from undergoing decomposition for many years. Thus, in the case of the arsenic-eaters of Styria the system becomes so saturated with the drug that when the graveyards are opened the bodies of those who had acquired the arsenic habit may be distinguished by their almost perfect state of preservation. There is also evidence to show that arsenic-eaters are particularly immune from infectious diseases.

It is, therefore, surprising to find that certain bacteria can not only live in a strong solution of sodium arsenite, but can also effect its oxidation. This remarkable phenomenon has been discovered by Mr. A. V. Fuller, and its practical importance is emphasised in a circular published by the U.S. Department of Agriculture, Bureau of Animal Industry. (No. 182, November 9th, 1911.)

It was found that arsenical dipping fluids used for washing sheep showed an apparent loss of arsenic after standing for some time in the vats. Experiments proved that this was not due to purely chemical reactions, but was caused by a spontaneous oxidation of the sodium arsenite to sodium arsenate, which escaped detection in the method of estimation employed. The oxidation was shown to be brought about by micro-organisms, which have not yet been isolated or identified. So rapidly did it take place under favourable conditions as to temperature, nature of nutrient substances present, and so on, that in some experiments the arsenic had been almost completely oxidised in the course of a few weeks. Thus, for example, a sample of dipping fluid which contained sodium arsenite in a proportion corresponding to 0·236 per cent. of arsenic trioxide was mixed with suitable nutrient media and inoculated with sheep dip in which the oxidising process had begun. The flasks containing the inoculated liquids were kept for a month at the ordinary temperature in the dark, being meanwhile shaken from time to time to promote the oxidation. Flasks containing the same dipping fluid which had been sterilised by heat were also exposed to the same conditions. At the end of the period it was found that the liquid in the control flask contained 0·222 per cent. of arsenic trioxide, whereas in the case of the inoculated samples the proportions ranged from 0·006 to 0·198 per cent. Owing to the varying conditions to which arsenical dips are exposed in practice, it has not been found possible to fix any limit of time during which a wash might be regarded as materially unaltered, and the circular therefore advises that all arsenical sheep dips should be discarded after being exposed for more than a few weeks, unless it is shown by a chemical estimation that they contain their original amount of arsenic trioxide.

SILOXIDE: A NEW GLASS.—Claim is made by MM. Wolf Burckhardt and Borchers, in a recently-published French patent (No. 432,780 of 1911), for a new glass which is prepared by fusing together pure natural silica with oxides of the silicon carbon group, preferably titanium or zirconium oxides or a mixture of the two. The resulting products are termed "Z-siloxide" or zirconium glass, and "T-siloxide" or titanium glass, and have many advantages over pure quartz glass, although they do not possess the same beautiful lustre. An experimental investigation of the new glass has been made by Mr. F. Thomas (*Chem. Zeit.*, 1912, XXXVI, 25), who finds that it is much less liable to undergo devitrification, and that it is less affected by the action of alkalies or other chemicals than quartz glass. The strongest zirconium glass was that containing one per cent. of zirconia, while the titanium glasses (containing 0·1 to 2 per cent. of titanium) were inferior to quartz glass in their power of resisting compression, but were still better than the zirconium glasses in resisting the action of heat. The new glass can be worked by the methods in ordinary use in the manufacture of glass.

AMORPHOUS SILICON.—A black silicon sulphide obtained by fusing together in an electric furnace a mixture of ferro-silicon and sulphur has been described by Dr. L. Cambi (*Chem. Zentralbl.* 1910, II, 1865). When this is hydrolysed it yields a chemically-active product, which has been found (*Atti Accad. Lincei. Roma*, 1911, XX, 440) to consist, in the main, of a variety of amorphous silicon. A fairly pure sample, containing ninety-six per cent. of silicon, had a specific gravity of 2·08, while the variety of amorphous silicon discovered by Vigouroux has a specific gravity of 2·35. This new form of silicon is a bright reddish yellow body, which, when heated for an hour at 900° C., in the absence of air, is transformed into a heavier brown product, closely resembling Vigouroux's silicon. The impurities in the active amorphous silicon consist of hydrogen and oxygen, which are probably in combination with the silicon.

PROPERTIES OF PURE VANADIUM.—Pure metallic vanadium has been prepared by Messrs. O. Ruff and W. Martin, and a description of the methods employed and the properties of the product are given in the *Zeit. angew. Chem.* (1912, XXV., 49). By fusing vanadium trioxide with a mixture of carbon and aluminium in the alumino-thermal process, a product containing from ninety-five to ninety-nine per cent. of vanadium was obtained. Or vanadium carbide was first prepared by fusing together in carbon crucibles (heated to a temperature of 2800° C.) a mixture of vanadium trioxide and carbon, and then fusing (at 2000°C.) a mixture of this vanadium carbide and vanadium trioxide in an electrically-heated furnace.

The melting-point of the pure metal was 1715° C., and its specific gravity at 18·7° C. was 5·688. In the fused condition it would dissolve either vanadium trioxide or carbide, to form mixtures of higher melting-points than the metal.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

THE INVARIABILITY OF IGNEOUS ROCK ASSOCIATIONS.—An interesting case of magmatic differentiation has been described from Tripyramid Mountain, New Hampshire, by Professor L. V. Pirsson and W. N. Rice (*Amer. Journ. Sci.*, April-May, 1911), which also raises the question as to how far certain associations of igneous rocks are invariable. The igneous complex, which has an oval outcrop measuring two miles by one and a half miles, is intruded into the great granite batholith forming the White Mountains of New Hampshire. It has a laccolithic habit, and a concentric arrangement of rock-types. There is an interrupted marginal zone of gabbro, with norite, followed by an unbroken zone of monzonite, whilst the interior of the mass is occupied by alkali-syenite (umptekite). The complex is accompanied by several dykes of camptonite, and is cemented along the joint-planes by dykes of aplite. The authors explain the phenomena by an hypothesis of successive intrusion with accompanying differentiation. The monzonite was intruded first with the concomitant separation of gabbro and norite on the margin. A second intrusion of monzonite then took place, with separation of the interior syenite. Lastly the joints and cracks in the solidified mass were cemented by the final residual product—a quartz-syenite-aplite. This explanation accounts for the arrangement of the rocks within the complex, and, at the same time, for the abrupt transitions and broken angular contacts between the various types.

The association of types, however, is rather unusual. Thus, alkaline types such as umptekite, monzonite and camptonite, are associated with calcic types, gabbro and norite, in the same complex. This seems to contravene the general rule, established for a great number of occurrences, that the alkaline rocks do not occur in association with the calcic, and raises the point as to whether these associations are really invariable. As Professor Pirsson remarks, some petrologists would consider the gabbro and norite as aberrant forms of essexite, the basic member which frequently completes an alkaline series. In that case, he rightly argues, the definition of essexite becomes so broad as to lose all specific value. If the Tripyramid gabbro and norite are not accepted as such, we are confronted with the alternative of calling similar rocks "gabbro" or "essexite," according to the association in which they are found.

Accepting the Tripyramid association, however, the great generalization of the invariable association of certain types of igneous rocks, based on numerous examples throughout the world, is not, we think, to be imperilled by small, isolated and exceptional occurrences such as this. Moreover, we note, from the chemical analyses given, that the norite and gabbro in this suite are considerably richer in alkalies (for a smaller silica content) than the average norite and gabbro, the composition of which is given in Daly's tables. The difficulty in nomenclature will probably be met by a closer characterization of igneous types. Thus the norites, a small, restricted, and comparatively rare group, still evidently include different varieties, not as yet expressed in the nomenclature, some of which may be associated with the alkaline, but the majority with the calcic series.

WATER SUPPLY AND THE DIVINING ROD.—The United States Geological Survey continue to issue their unique series of Water-Supply Papers. The frequency with which a second edition or reprint of many of these publications is demanded is proof of their utility to the public and an example of the excellent economic work that can be carried on by a national survey when a broadminded Government provides adequate funds for its proper upkeep. One of the latest of this series to achieve a second edition is Paper No. 255, on "Underground Waters for Farm Use," by M. L. Fuller. This paper deals in simple language with every conceivable phase of water-supply on farms and cannot fail to be of immense practical value to English-reading farmers everywhere. Seventeen well-chosen plates and twenty-seven diagrams help out difficult places in the text.

Mr. Fuller gives an interesting note on his own experience of the divining rod, the simple forked branch of witch hazel used by the so-called water witches as an indicator of underground water. We quote his remarks (page 15): "In experiments with a rod of this type, the writer found that at certain points it seemed to turn downward independent of his will, but more complete tests showed that this down-turning resulted from slight and, until watched for, unconscious muscular action, the effects of which were communicated through the arms and wrists to the rod. No movement of the rod from causes outside of the body could be detected. . . . . The uselessness of the divining rod is indicated by the facts that it may be worked at will by the operator, that he fails to detect strong water current in tunnels and other channels that afford no surface indications of water, and that his locations in limestone regions where water flows in well-defined channels are no more successful than those dependent on mere guesses. In fact, its operators are successful only in regions in which ground water occurs in a definite sheet in porous material or in more or less clayey deposits, such as pebbly clay or till. . . . . No appliance, either mechanical or electrical, has yet been devised that will detect water in places where plain common sense will not show its presence just as well. The only advantage of employing a 'water-witch' . . . . is that crudely-skilled services are thus occasionally obtained, since the men so employed, if endowed with any natural shrewdness, become through their experience in locating wells better observers of the occurrence and movements of ground water than the average person."

BRITISH PILLOW-LAVAS.—Two further occurrences, in the Tavistock-Launceston area, and in the Kilbride Peninsula, Mayo, have been added to the already long list of pillow-lavas, which are so well-developed upon several Palaeozoic horizons in Great Britain.

These rocks usually belong to the peculiar group of the spilites, in which felspars rich in soda form the major part of the rock, with subordinate augite, occasional olivine, and some glassy base. A distinctive micro-structure is shewn by the felspars, which are long, acicular and pointed, with fluidal arrangement, but often also variolitic. The spilites are associated with albite-diabase, minverite, picrite, quartz-diabase, keratophyre and soda-granite, forming a well-characterised group of rocks named by Dewey and Flett the "spilitic suite."

The new Devonian occurrences are fully described in a recently-issued Survey Memoir on "The Geology of the country around Tavistock and Launceston." They belong to two horizons, the Upper Devonian and the Lower Culm Measures. Many of them are highly decomposed and rendered schistose by pressure, so much so that it would be more correct to describe them as schalsteins. The intrusive rocks associated with the spilites are quartz-keratophyre, minverite, picrite, and quartz-diabase.

The Irish pillow-lavas are described by Mr. C. I. Gardiner and Professor S. H. Reynolds, in a paper on "The Ordovician and Silurian Rocks of the Kilbride Peninsula (Mayo)" (*Q.J.G.S.*, February, 1912), an addition to the important series of papers by these authors on the Palaeozoic Rocks of the West of Ireland. The pillow-lavas are here associated with sediments of Arenig age, and belong to a widespread and extensive series. Spilite and felsite breccias occur proving the presence of an acid magma at no great distance, although no acid lavas have been found in the area. Later on, but almost certainly in Arenig times, one large and many small intrusions of felsite took place. No contemporaneous basic intrusions appear in the area. At an early post-silurian date, however, lime-bostonites and labradorite-porphyrites, which may form part of a later spilitic suite, were intruded.

Ordovician pillow-lavas are also known in the Girvan-Ballantrae district of Ayrshire, and Megavissey and Mullion Island in Cornwall, pointing to a spilitic petrographical province of enormous extent covering the Western British area in Ordovician times.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended February 17th, as set out in the Weekly Weather Report issued by the Meteorological Office, was very dull generally, with a good deal of fog and mist in places. Temperature was above the average in all districts, the excesses varying from 2°·7 in Scotland, E., to 5°·4 in England, E. Maxima above 50° were recorded in all parts of the country, the highest being 57° reported at Tottenham, Llandudno and Killarney. The minima were below the freezing point in all districts except England, E., and the English Channel. The lowest reading reported was 25° at West Linton on the 11th. In the Channel Islands the temperature did not fall below 38°. On the grass readings down to 18° at Dublin and 19° at Aspatria, were observed.

Rainfall was slightly in excess in England, N.E., the Midlands, and England, S.E., but was in defect elsewhere, the greatest defect being in Scotland, N., where it was but one fourth the average amount. Sunshine was less than usual in all parts except Scotland, N. In that district the daily duration was 2·2 hours (24%), while in the English Channel it was 2·7 hours (27%). In England, N.E., however, the daily amount was only 0·2 hour (2%). At several stations the week was sunless, Westminster reported 0·7 hour (7%).

The mean temperature of the seawater round the coasts varied from 37°·9 at Burnmouth to 46°·7 at Salcombe, and was, as a rule, a little above the normal.

The week ended February 24th was cloudy and damp, with fog and mist on the coast. Temperature continued high and was again above the average in all districts, by as much as 7°·4 in England, E. A maximum reading of 60° was recorded at Birr Castle, Ireland, on the 22nd, the next highest reading being 58° at Hawarden Bridge, near Chester, on the same day. In Jersey the highest reading was 56°. Frost was recorded in all districts except the English Channel, where the minimum was 30°. The lowest of the minima reported was 25° at Llangammarch Wells, but the thermometer on the grass at that station fell to 20°. At Dublin the grass thermometer was as low as 19°. The temperature at one foot below the earth surface was above the normal at all stations and by as much as 5° in the South-East of England.

Rainfall was in excess in all districts except England, N.W., the difference from average being considerable in places, especially in Ireland.

Sunshine on the other hand was in defect in all districts except Scotland, W., where it was slightly in excess. The sunniest district was Ireland, S., with a daily value of 2·8 hours (28%). At Westminster the daily amount was only 0·1 hour or 1 per cent.

The temperature of the sea water was higher than usual, and the mean values varied from 38°·0 at Burnmouth to 48°·1 at Salcombe.

The week ended March 2nd was very unsettled, with rain on most days. In the extreme N. and N.W. the rain was sometimes heavy. Temperature continued above the average, the excesses above the normal being very high, 10°·0 in England, E., and nowhere less than 6°·2. The maxima, however, did not exceed 60° at any station, but this value was recorded at many stations between York and Jersey. The high average was due to the high minima, and in each district the average of the minima this week was higher than the normal average temperature, the excess in England, E., being as much as 4°·6. On the grass the lowest readings recorded were 23° at Rauceby and 24° at Crathes and Markree Castle. The earth temperature at one foot depth was higher than normal at all stations.

Rainfall was slightly below the normal in the Midlands and North-Eastern districts, but was in excess elsewhere, especially in the North. At some stations the total precipitation was more than twice as much as usual. Thus, at Stornoway the total was 2·84 inches as compared with the average of 0·99 inch, and at Newton Rigg 1·38 inches compared with the average of 0·67 inch. Sunshine was below the normal in all parts, the sunniest district being the English Channel with a daily [illegible] hours (2[illegible]%). Of the [illegible] stations, Torquay [illegible] sunshine, [illegible] hours per day (36%). The [illegible] varied from 38° at Burnmouth to 50° at Penzance and Scilly.

The week ended March 9th was again unsettled, with frequent rain at [illegible] in the West and South-West. A feature of the [illegible] well-marked line-squall that travelled from the S.W. [illegible] to the S.E. of England on the 4th, accompanied by sharp thunderstorms and exceedingly heavy gusts of wind. The maximum velocity recorded in the squall was eighty-nine miles per hour at Falmouth, Pendennis, but a few hours later a gust of ninety-eight miles per hour was recorded at the same station.

Temperature was again above the average in all districts, the excesses, however, being of less amount than in the preceding week. The high average was due as before to the high minima, for the maximum nowhere exceeded 58° which was the reading at Jersey on the 5th. In most districts the maxima for the week were below 55°, and in Scotland, W., the highest reading was only 50°. The minima, on the other hand, were high and there was but little frost. The lowest reading recorded was 28° at Nairn and at Balmoral on the 8th. In Scotland, W., the temperature did not fall below 34°, and in the English Channel the lowest reading was 36°. On the grass, however, severe frost was registered, the readings falling to 20° at Crathes and to 21° at Plymouth and Southampton. At a depth of one foot the earth was much warmer than usual. Rainfall was slightly below the average in Scotland, N. and E., but above it in all other districts. In England, S.W., and the English Channel, the totals were nearly three times the usual quantity. The week was much more sunny than those which immediately preceded it, and daily averages were reported up to 5·1 hours (46%) in Ireland, S. All the districts showed excesses except England, N.E., and the English Channel, which were slightly in defect.

The mean sea temperature ranged from 39°·9 at Burnmouth to 49°·0 at Newquay, which was considerably above the average.

The past "Winter," that is, the period of thirteen weeks, December 3rd, 1911, to March 2nd, 1912, has been on the whole warm and wet, but dull. In England, S.E., of the thirteen weeks six were unusually warm, five normal and two cold; nine weeks were unusually wet, three normal and one dry, but only two weeks unusually sunny, one normal and ten dull.

MICROSCOPY.

conducted with the assistance of the following microscopists:—

ARTHUR C. BANFIELD.	ARTHUR EARLAND, F.R.M.S.
THE REV. E. W. BOWELL.	RICHARD T. LEWIS, F.R.M.S.
JAMES BURTON.	CHAS. F. ROUSSELET, F.R.M.S.
CHARLES H. CAFFYN.	D. J. SCOURFIELD, F.R.M.S.

C. D. SOAR, F.L.S., F.R.M.S.

AN ATTRACTIVE "COMMON OBJECT."—An interesting but perhaps little-known micro-object, plentiful in spring, may be found at the base of old dead nettle stems. The stem should be carefully drawn out from the ground after first loosening the earth round it. On examination it will be found in nearly every case, that under the cuticle just above the root, there are a number of little black points. With a moderate magnification they are seen to be flagon or bottle shaped bodies; when not crowded many are very symmetrical in form, while others owing to pressure and crowding are more or less mis-shapen. They have a narrow neck which pierces the cuticle, appearing on the exterior as a minute papilla with an orifice at the summit. These are specimens of the ascomycetous fungus *Sphaeria acuta*. If the stem supporting them is carefully dried they form an attractive object for a low power—say one inch or one-and-a-half inches—under incident light especially with a binocular. With very little trouble a preparation showing their minute structure may be made. For this purpose they should be detached with as little injury as possible, and should be soaked in strong spirit for some hours; then a little glycerine (diluted [illegible] the [illegible] for ap- [illegible] will [illegible] needles. The [illegible] shaped [illegible] sometimes difficult [illegible] and are transparent, packed in as [illegible] *paraphyses* (Figure 176, A). The [illegible] generally slightly curved [illegible] and divided by from five

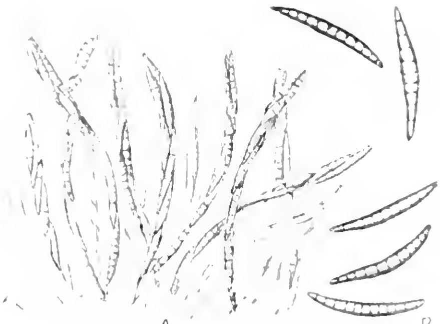


FIGURE 176.

[illegible] cross-walls (Figure 176, B). They are arranged in a double row with the ends overlapping, frequently in a spiral manner, see Figure 176, A. It may happen that the flask-shaped body contains only minute simple spores, free in the interior without any asci, in which case the specimen is an incompletely developed form of the same organism and has received the name *Apospaeria acuta*, vide Dr. Cooke's "One thousand objects for the microscope," No. 336. Almost certainly another form exists also, and is probably included in the genus *Macrosporium*, as a species closely related to the one we are considering (*Sphaeria herbarum*) is known in one stage as *Macrosporium sarcinula*, vide "KNOWLEDGE" for October, 1911, page 406. The asci and spores mount nicely in glycerine jelly, or they may be stained and mounted in glycerine. The figure was drawn from a specimen treated in this way; the *paraphyses* (A) × 180 and the separate spores (B) × 340.

JAS. BURTON.

THE PYGIDIUM OF A FLEA, as mounted by Topping, was formerly sold as a test object, but although in consequence of the improvements in objectives it is no longer regarded as such, it is still an object of great interest to the microscopist on account of its intricate structure, and it has also a claim for consideration inasmuch as it represents a class of organs which are comparatively rare in the insect world. A pygidium, properly so called, is the terminal segment of an insect's abdomen, whether or not it bears the peculiar structure usually known by that name. "The pygidium of a flea, as commonly understood, is a paired organ, the two lobes of which are in close proximity, enclosed in the same band of chitine and separated only by a narrow ridge of short stiff hairs; the length of the ridge in the specimen before me is one seven hundred and fiftieth of an inch, whilst the breadth of the entire organ, including the ridge is one four hundred and eightieth of an inch. The anterior margin of the band is smooth in outline, but the opposite side terminates in two processes, each of which carries a long stiff spine and is surrounded by numerous hairs of shorter growth. The general surface of each lobe of the pygidium of a flea is studded with minute papillae, short and bulbous at the base, but tipped with a sharp apical spine, and amongst these are placed a number of curious circular depressions, or areolae, the two thousandth of an inch in diameter, bordered by a ring of cells, from the inner margin of which seven to ten serrated wedge-shaped plates, about one quarter the diameter of the discs, radiate towards the centre, somewhat like the spaces between the spokes of a cart wheel. From the bottom of each depression a long delicate filamentous hair arises from a conical base and passes through the central opening of the areola. The number of areolae in the pygidium varies according to the species of flea; in that of a cat it is twenty-eight, but in that of an abnormally large specimen of doubtful origin in the cabinet of the Quekett Microscopical Club there are no less than sixty-four, together with a pair of remarkable appendages extending from either side of the anterior portion of the pygidium, which have not been noticed elsewhere. As regards the function of this organ there has been much speculation. All observers agree that it is a sense organ, but of what sense has been a matter of dispute, though the balance of evidence is certainly in favour of its being an organ of hearing. Those who have watched a flea when feeding will have noticed that whilst the head is so much depressed as to preclude observation of its surroundings by the eyes, the abdomen is so elevated as to make the pygidium the highest portion of the body, in which position it would undoubtedly be best situated for perceiving the sound of approaching danger. The Lace-Wing fly, *Chrysopa perla*, has a similar organ on either side of the last segment of the body, the use of which is also problematical; the following observation, however, tends to support the idea that the function of the pygidium is auditory.

Some years ago a friend in Natal informed me that he had frequently noticed that when a Cicada was singing, it was attended by a number of Lace-Wing flies which were apparently attracted by the music, and from their movements appeared greatly to appreciate it. Many futile attempts were made to capture some of them, but as soon as my friend's approach was perceived the Cicada ceased its song and the audience took flight. At length, having one day noted their exact position on a tree trunk, he approached stealthily from behind, and by suddenly clapping his hands upon the place, succeeded in securing ten of the flies in question, which were subsequently identified as *Notochrysa gigantea*. The method of capture did not conduce to the specimens being in very good condition, and being very dry when they reached England it was not possible to dissect them with hope of success, but enough was seen to show that each of these flies had a large and prominent pygidium on each side of the last segment of the abdomen, each of which bore not less than forty areolae with a long sensitive filament upstanding from the centre, although the radiating plates appeared to be absent.

R. T. L.

THE FINE ADJUSTMENT. Provision for the focussing movements of a microscope is made by means of slides, consisting of fixed and moveable parts accurately fitted together, one of them carrying the tube. The two parts are either dove-tailed one into the other, or made up of a sleeve fitted over a fixed prismatic bar, usually of triangular section. A micrometer screw is used to convey movement directly to the slide bearing the tube, or indirectly through a lever or some other mechanical arrangement for reducing

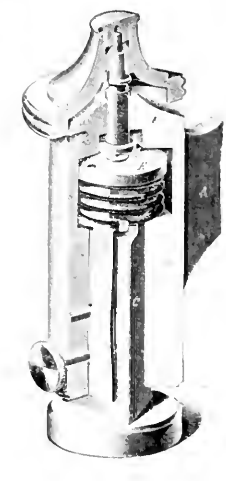


FIGURE 177.
Prismatic Bar Fine Adjustment.

the route of motion. The dovetail bar is a common one and accurate slide, and when it is used the action of the micrometer screw is generally direct, and raises or lowers the sleeve which carries both the arm and tube of the microscope. Dovetailed slides are usually placed immediately behind the coarse adjustment and carry the latter and the tube only, with the advantage that the arm may be lengthened to give greater stage-room without adding to the weight borne by the fine adjustment. A direct acting micrometer screw is under these conditions inconvenient, and some intermediate mechanism is usual, generally a lever, but a few makers use a cam or some adaptation of the principle of a wedge. There are many different varieties of these broad types, and the methods by which the screw or lever, and so on, are utilized, are more or less special to individual makers. The six examples given are selected as showing a fairly wide range.

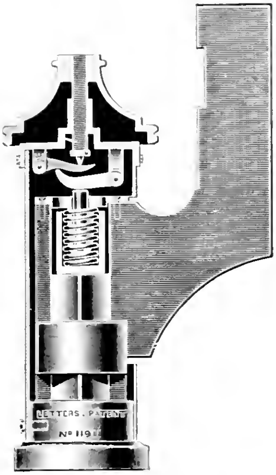


FIGURE 178. Ariston Fine Adjustment.

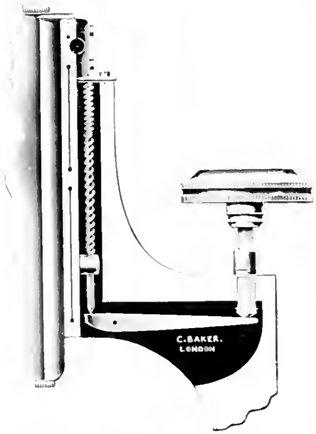


FIGURE 179. Lever Fine Adjustment.

THE DIRECT-ACTING MICROMETER SCREW AND PRISMATIC BAR FINE ADJUSTMENT. Figure 177 shows the form adopted by Zeiss. The arm (A) and tube of the microscope are carried on a sleeve (B) which slides upon a vertical triangular bar (C). A nut (E) is screwed on to the top of (C) and a spring presses against it and against (B). The hardened steel point of the micrometer screw bears on the similarly hardened centre of (C) and works through (F) which is screwed to the sleeve. When the micrometer screw is turned downwards the tube travels upwards and the spring is compressed. The latter in its turn causes the downward motion as the screw is turned up. This then is a safety fine adjustment, as the objective cannot be screwed by it down on to the cover glass. Most prismatic bar fine adjustments are liable to damage if the microscope is lifted by the moveable sleeve, but in this case the danger to the micrometer screw is minimised by fixing it to the tube carrier. If the microscope is lifted by the latter the screw is lifted too, while the lower part of the instrument drops until stopped by the counter-nut screw on top of the prismatic bar.

THE ARISTON FINE ADJUSTMENT. The fineness of motion imparted by a direct-acting micrometer screw obviously depends on its pitch, which is generally about one-fiftieth of an inch (·5 mm.), and one rotation of the milled heads raises or lowers the microscope tube through that distance. This is not a very slow motion, though adequate for most purposes, and several methods have been adopted to make the movement slower. It is not advisable to use much finer screws, as they are very liable to damage. Messrs. Swift reduce the speed to one-third by interposing toothed wheels, while retaining the general characteristics of the direct-acting screw, as shown in the Ariston fine adjustment. See Figure 178. This and most other prismatic bar fine adjustments differ from that of Zeiss in that the pressure of the spring raises the microscope tube, while the action of the screw presses it downwards: that is, they are not generally of a safety type. On the other hand, the Ariston has the great advantage in that the moveable sleeve carrying the limb has a protecting cover screwed over it, by which the microscope can be lifted without damage to the mechanism. The Spencer Lens Company give similar protection by fitting a stout guard below the limb.

LEVER FINE ADJUSTMENT. Figure 179 shows a simple but very efficient way of using the lever in fine adjustments, a method that, with variations in detail is very largely employed on English and American stands. It has the following points of interest. By placing the fulcrum of the lever in suitable positions, any desired ratio can be got between the upward motion of the end of the lever carrying the tube and the downward movement of the other end caused by the screw. A very fine motion can consequently be obtained from an ordinary micrometer screw. For instance, Watson and Beck provide a movement of one three-hundredth of an inch with a screw of one-sixtieth of an inch pitch. In the form adopted by Baker the screw is of one seventieth of an inch pitch and the arms of the lever are as three is to one, so that one rotation of the milled head raises the tube one two hundred and tenth of an inch. It is a safety adjustment, as the downward motion is caused by the weight of the tube and the spring, which also keeps the lever always up to its work against the screw. The bearing points and surfaces are, as in all the adjustments, of hardened steel. And the limb can be used as a handle without any danger to the mechanism.

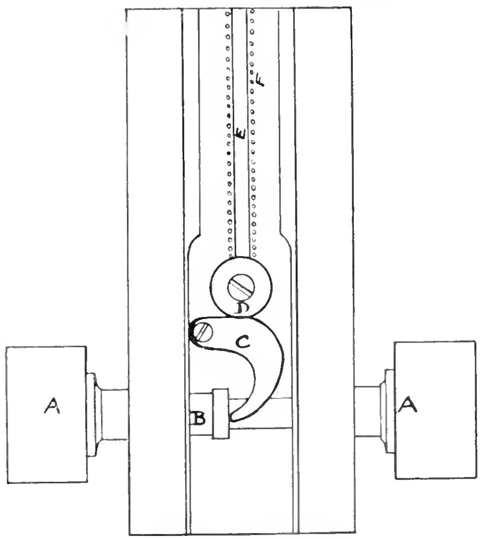


FIGURE 180. Baker's New Lever Fine Adjustment.

Beck's [illegible] Fine Adjustment (Figure [illegible]) [illegible] drawn [illegible] fine adjustment [illegible] excepting [illegible] for [illegible] the milled heads are placed [illegible] Beck and the Stereo [illegible] use [illegible] the same [illegible] the milled head [illegible] the micrometer screw [illegible] the inch. Motion [illegible] curved lever (C, [illegible] to four, to a [illegible] wheel (D) intended to eliminate friction as much as possible. The lever is curved where it touches (D) in such a way as to ensure that the latter carrying the tube is raised an equal amount for each rotation of the milled heads. A spring (E) on the guide pillar (L) keeps the wheel down to its work and causes the downward motion. Each revolution of the milled heads corresponds to a movement of ·125 millimetres or one two-hundredth of an inch. All cocks in this and the last adjustment are sprung and screwed.

The position of the milled heads found in this fine adjustment is very much in favour now, and adopted by many makers, but it must not be supposed that that indicates a similarity in the working parts enclosed in the limb. That of Zeiss, for instance, is actuated by a micrometer screw (see Figure 181).

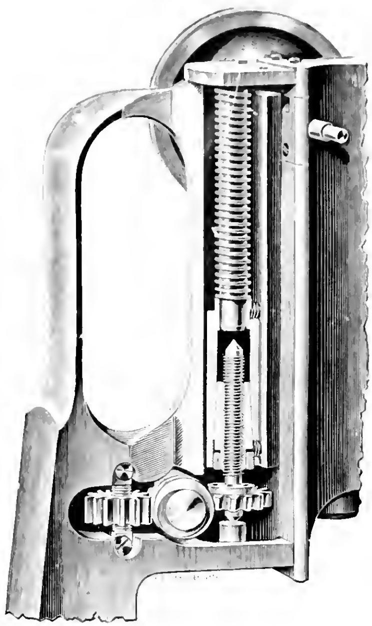


FIGURE 181.

Berger Micrometer Screw Fine Adjustment.

Berger's Micrometer Screw Fine Adjustment. (Figure 181). The milled heads actuate a worm which in its turn rotates a cogwheel attached to the micrometer screw. The latter works in a socket firmly fixed to the sliding bar, so that if the milled head is turned to the left the tube will be raised. When turned to the right the socket is brought downwards on to the screw by the spring and tube weight only and disengages from the screw should the objective touch the cover glass. The guiding cogwheel to the left moves up or down as the milled heads are turned until it reaches the casing and so acts as a stop to the maximum and minimum movement of the adjustment. One rotation of the milled heads gives a movement of one two-hundred-and [illegible]th of an inch or 0·1 millimetres.

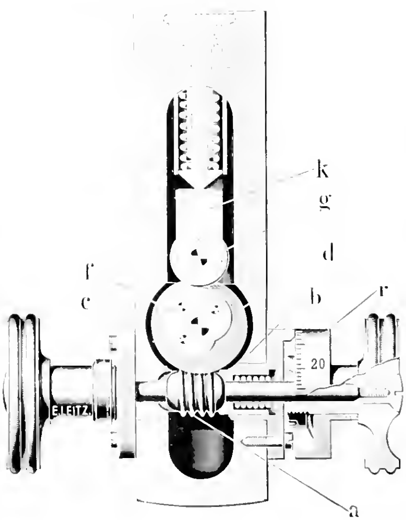


FIGURE 182.

Leitz New Fine Adjustment.

Leitz' New Fine Adjustment (Figure 182) is illustrated as an example of one of the fine adjustments in which mechanical arrangements other than a screw and lever are employed. The lateral milled heads convey motion to a wheel (d) by worm gear (e). This wheel carries a heart-shaped eccentric cam (f) and on this a [illegible] roller is pressed by the weight of the tube assisted by a spring. As the cam is turned the roller which revolves upon it is lifted upwards carrying the microscope tube with it, or falls by the weight of the latter and the spring. One revolution of the milled head corresponds to a rise or fall of ·1 millimetre (·[illegible] inch). Examination of the figure will show that instead of a limit to the movement of the milled heads in both directions, as there is with most fine adjustments, the motion is continuous and a further rotation when the tube is raised or lowered by the cam to its greatest extent instantly reverses the motion. The rise and fall due to the rotation of the cam is three millimetres, so that reversal need very seldom occur. Continuous fine adjustments have the advantage that there is no fear of damage due to the arrival of the movement at its upper or lower limit. But the uncertainty as to whether one is focussing up or down is occasionally a drawback, although a glance at the indicator on the sliding bar and limb serves to show the direction of movement, and as the milled heads can be made to work in the same direction as those of the coarse adjustment at any time the difficulty should seldom arise.

The milled heads of any fine adjustment can be had graduated in fifty or one hundred divisions, so that the amount of motion given can be determined when required for purposes of measurement.

The testing and selection of a fine adjustment is almost as important as the choice of objectives; for unless the former is satisfactory it is impossible to use the lenses to their best advantage. The work put into modern microscopes is so uniform in quality that the efficiency of any adjustment fitted by a maker of repute may be relied on. One may be slower in motion than another, but it is not fair to say on that account that it is better, unless the use to which the instrument will be put is known. A movement of one-fiftieth or one-sixtieth of an inch for each rotation of the milled heads is quite adequate for low and medium powers, and in many cases preferable to a slower one as more durable and tending to save time in laboratory work. But for high powers and particularly for photo-micrography it is difficult to get too slow a fine adjustment. The advantages of a fast and slow motion are often combined in the same instrument by fixing a spindle of small diameter to the centre of the milled head. It may be rapidly rotated when a faster movement is desired. Secondary levers are sometimes added to reduce the speed of a fast type, as in the Ariston, or the Males-Watson, which is provided with two milled heads. Becks use two concentric micrometer screws of different pitch to actuate their lever fine adjustment, giving movements of one-sixtieth and one-three-hundredth of an inch respectively.

Safety types have a distinct advantage over other adjustments, and the liability to damage of the adjustment itself must not be overlooked.

The position of the milled heads should be such as to permit of the hand or arm resting on the table while using them.

Above all, particular attention must be paid to the sweetness and steadiness with which the adjustment works, and the following faults should on no account occur in use: Backlash, loss of time or sag on reversal of movement, lateral movement of the object across the field. And there should be no tendency for an object to go out of focus if the table receives a slight jar.

These are all guarded against by well-fitting slides and the provision of suitable springs to keep the mechanism up to its work. Good working properties are ensured in different ways by different makers and it will be well in this connection to compare the advantages claimed for *sprung and ground-in slides*. If the adjustment slides of various microscopes are examined, some will be found to be "sprung" or slotted and held up true with screws, while others are not. Reliance, in the second case, is placed on the fit produced by grinding one part into the other. In support of sprung slides it is urged that when play through wear becomes noticeable, it may be taken up by tightening the screws and without returning the microscope to the maker. But against this advantage must be placed the difficulty of so exactly adjusting the screws that the slide works truly throughout its entire length and not only at a greater or less number of points. The alternative method of grinding one bearing part accurately into the other is now generally acknowledged as the better, but it involves the expenditure of much time in making a good fit and the use of very good materials if it is to wear well. Play is generally less than that in sprung slides, but when it does occur the microscope must be sent to the maker for readjustment. A good fitting should last for many years without any undue evidence of shake.

H. Lloyd Hind, B.Sc., F.I.C.

QUEKETT MICROSCOPICAL CLUB. February 27th, Annual General Meeting. The Presidential Address was delivered by Professor E. A. Minchin, M.A., F.R.S., who took as his subject "Some speculations with regard to the simplest forms of life and their origin on the earth." The most distinctive property of living things is the power of metabolism. All living bodies consist essentially of protoplasm which is composed mainly of proteins. In all living organisms certain granules of a peculiar substance, chromatin, are found in the cytoplasm. Chromatin consists of protein substances more complex even than those found in the cytoplasm. The simplest forms of life appear to be little or nothing more than minute grains of chromatin. There are two views with regard to the nature and composition of the body in the simplest and most primitive forms of life; the first, the chromatinic theory, assumes that the primitive living substance is chromatin, and that the earliest forms of life were minute particles of chromatin; the second, the cytoplasmic theory, regards the cytoplasm as the primitive living substance, and supposes that the earliest living things were composed of cytoplasm alone. As an example of theories which maintain that life originated on the earth, that of Sir Ray Lankester was mentioned, according to which it is supposed that life originated at the time when the earth had cooled down sufficiently to have a firm crust upon which water was condensed. The chemical and electrical disturbances which undoubtedly then occurred might conceivably have brought about synthesis of organic compounds in a manner and to an extent which does not occur at the present day. This synthesis might conceivably have culminated in proteins and the production of the earliest protoplasm, and the earliest living things would probably have been relatively large masses of cytoplasm, in which chromatin was a product formed later. As an example of theories which assume that life was in some way brought to the earth when it was cooled sufficiently for life to exist upon it, that of Professor Arrhenius was taken. He regards life as eternal and coeval with our universe, and believes that it exists throughout the universe in the form of minute particles (? chromatin), which are transported through infinite space by radiation pressure. A particle in size of the order of 0·16 would be required, and it is probable that some of the almost invisible microbes of certain diseases (Chlamydozoa) are of smaller dimensions than this value. It is not possible to decide in favour of the one theory or the other in the present state of our knowledge of living things.

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

CASUAL BIRDS IN THE BRITISH ISLES. Birds as a class are great vagrants, and the avi-fauna of the British Isles is steadily being augmented by new species, such as those which have been reported in recent numbers of "Knowledge." These, with other very rare occasional and accidental visitors, may be called natural "casuals." It is difficult to draw a line between rarity in the occurrence of a species and casualness, for it is not adequate to say that, in the last-named, what is called "chance" must be present. Under quite natural conditions it seems to be the same factor of chance which shapes the destiny of those bird-waifs, many different kinds of which have now occurred in the British Isles, often blown or strayed out of their course on migration. In illustration of the large casual or occasional element amongst British birds it may be said that, of the four hundred and fifty species or thereabouts now admitted to our list, no fewer than two hundred and seven are classed as occasional visitors and not breeding. These cannot all or always be correctly called casuals, but a large number of them have the most slender claims to be called British. Of the two hundred and seven, some one hundred and five have not occurred more than six times each, and some of these only once or twice.

A much less questionable casual element is composed of foreign species, mostly introduced by man, and taking to freedom for a time or tentatively. This excludes such birds as the Pheasant and Red-legged Partridge which have been long naturalized in this country. Accidental or temporary introductions are a different thing, and the following incident is suggestive of what may have often happened, although perhaps not in quite the same way. When the steamer "Minnehaha" was wrecked on the Scilly Isles, in April, 1910, a number of American birds on board, consigned from New York to the Zoölogical Gardens, London, were liberated to give them a chance to save themselves. Amongst them were Parrotlets, Ground Doves, Inca Doves, Crested Quails, Red-winged Starlings and Purple and Bronze Grackles, which, if finding their way ashore, would make a strong casual element for, at any rate, a brief time in the avi-fauna of the place. Ships, unwittingly, and sailors and travellers purposely, often bring foreign animals of different kinds to our country, birds probably most abundantly. When the steamer "Mauretania" was about five hundred miles out from New York, eastward bound, on 15th June, 1911, a Curlew came on board and remained for three days, leaving only when the Irish Coast was sighted (Coward's "Migration of Birds," 1912. Page 122). No doubt it made the land and thus joined the bird population of the British Isles. Even native species are sometimes so conveyed, as the case of the Peregrine Falcon given in the last issue of "Knowledge" (page 116) shows.

The spire of Shoreditch Church was the home of a solitary Falcon for many years, and Kites which were liberated from the Zoölogical Gardens, London used to return there to feed. A Black Kite, which had escaped from its cage there, would fly over the heads of visitors quite unconcerned, in the hope of having tit-bits thrown to it. The sight of this raptorial bird on the wing caused so great a panic amongst the smaller birds in the aviaries that after a week's freedom it was induced to return to its cage. A still larger bird of prey which has accidentally been at large in London is the Vulture. In August, 1898, five Jamaican Vultures were free in the Borough, haunting the house-tops and steeples for some days; and in the same month one, which was consigned to the Hungarian Exhibition, Earl's Court, escaped from a broken crate and took to such freedom as the neighbouring roofs afforded.

When it is remembered that ornamental Water Fowl of many kinds are kept in ponds and lakes in a large number of places both public and private, and that numbers of foreign species are among them, it is only too [illegible] that escapes take place and form [illegible] and irregular and unsuitable addition to "British" Birds. Recent examples of this kind are the American Wigeon, Baikal Teal, Ruddy Sheldduck, Snow Goose, and probably the American Bittern, and the list could be continued indefinitely. Some of these birds also occur truly wild. On the ponds in St. James' Park, London, some forty different kinds of birds are kept, and at places like Woburn Park, Bedfordshire, many species of non-British geese, ducks, and other water-fowl breed year after year successfully. Some other foreign birds are at liberty at Woburn all the year round, such as Red-Crested and Dominican Cardinals, which nest in the gardens and have young. Orange Weavers have made a nest there, but no eggs were laid. There are also numbers of the Australian Crested Pigeon (*Ocyphaps lophotes*) and the Bronze Winged Pigeon (*Phaps chalcoptera*) in the Woburn Woods at large. Australian Doves, liberated from the Zoölogical Gardens, bred in the trees in the grounds and in the park, and some wandered off. There is a definite record of the escape from Woburn of a South American Lapwing (*Vanellus cayennensis*), which was shot some distance away as an unknown bird.

Flamingos have occurred very rarely wild in this country, but it is known that birds of this kind sometimes get away from Woburn and, no doubt, from other collections also. One, for instance, seen feeding on the Glamorganshire coast, in December, 1908, was supposed to be a bird which had made its escape from Cardiff Castle three weeks previously. A Flamingo recently flew, assisted by a gale of wind, from the Zoological Gardens, London, into the open park and going out of sight over the tree-tops was given up for lost, but circling round in the air it returned to the park and was secured. An odd "Zoo" story is that of a young Penguin which about a year ago escaped and was discovered walking along Baker Street (so the newspapers stated at the time). Later on the same bird was missing again and was believed to be in hiding in Regent's Park and living on the fish in the lake.

At present there is a pair of red-breasted Cockatoos at liberty from the "Zoo" and there is no intention of recapturing them, so long as they do no mischief. They take long flights in the Gardens and at dusk fly off and roost in the elms in Regent's Park. It is not unlikely that they may nest in the spring in these high trees and thus be genuine casuals, as this hardy bird can well take care of itself. In 1908, one was shot which had been robbing a poultry-yard in Glamorganshire. It was mistaken for a hawk, being quite wild, and the place from which it had escaped could not be ascertained, nor the time during which it had maintained itself free. It has sometimes been suggested that Parakeets might be liberated in English parks as ornamental birds, but this would be dangerous as, it becoming abundant, they might do damage to growing crops and to some of our native birds. At present Ring-necked Indian Parakeets, belonging to Mr. W. Jamrach, are at liberty at Stoke Newington, and come down to feed in the poultry-yard. They live day and night in the open and if they survive, it is proposed to liberate others there.

Pekin Robins (*Liothrix luteus*) have been tried in St. James' Park, London, and probably elsewhere, but, so far as I know, without success. American Robins (*Turdus migratorius*) were turned out near Guildford in 1908 or 1909, and freely nested there, increasing in numbers considerably. To such introductions as these ornithological purists are strongly opposed, particularly if success is attained. The case of the Little Owl (*Athene noctua*), which has now established itself in many places in England, is looked upon with reprobation, and that of the Willow Grouse (*Lagopus albus*) is considered quite as reprehensible in the areas where it has been introduced. The American Wild Turkey has been tried at Luss and Inveraray and probably elsewhere, but has not made good its footing, or spread. Purple Gallinules (*Porphyriola alleni*) have been shot in various parts of England, but this is an Australian bird often kept with ornamental water-fowl, and being a great climber it can get over high wire netting and thus escape.

The Albatross is probably the most conspicuous casual recorded in our avi-fauna. The Black-browed Albatross (*Diomedea melanophrys*) occasionally finds its way into European waters, and one was taken alive near Linton, Cambridgeshire, in 1897. I believe that instances are known of Albatroses having been brought over the line on board ships, and allowed to fly off on the northern side. They would be likely to take a northern course, and this may account for the occurrence of the species in Europe (J. E. Green, "Ocean Birds," page 4). The one or two old records in England of the Tropic-bird (*Phaeton*) may be accounted for by conveyance by ships, or may have been caused by violent storms.

There is a remarkable instance of a Bird-of-Paradise (a hen Rifle-bird) living in freedom for ten weeks in Sussex. Hens of this species were imported from New Guinea into this country for the first time in 1908, and one managed to escape when being transferred from its travelling cage to the large aviary for which it was destined near Groombridge. It was lost sight of from 7th September till 19th November, and was supposed to have completely disappeared, when, on the last-named date, it stunned itself by dashing against the window of a house about two miles away from the place where it had escaped. It soon recovered and was found to be in good health, and was committed to the aviary for which it had been intended. It is a demonstration of the hardiness of such birds, and probably a unique casual case in our country.—*Read before the Hampstead Scientific Society, February 8th, 1912.*

MENDELIAN EXPERIMENTS.—At the scientific meeting of the Zoological Society, London, on 6th February, two papers on Mendelism were read. The first, by Mrs. Rose Haig Thomas, described a breeding experiment which she had carried out with pheasants in order to confirm one previously made in which a cock pheasant had transmitted the female plumage of his species to his female offspring of the F 2 generation. This second experiment was conducted with the Formosan pheasant (*P. formosanus*) and the Japanese pheasant (*P. versicolor*), and produced a similar result. The second paper, by Mr. J. T. Cunningham, dealt with the characters of a number of individuals of the F 2 generation, reared from a cross between a Silky hen and a Bankiva cock, bred in the Society's gardens by Mr. D. Seth-Smith. The author described the various characters in detail, and remarked that the most important results obtained were imperfect segregation in the F 2 generation in at least two of the characters—*viz.*, absence of pigmentation in the plumage, and also in the skins and tissues.

PHOTOGRAPHY.

By Edgar Senior.

INFLUENCE OF ULTRA-VIOLET RAYS.—In "Notes" for last month we showed how the suggestion put forward by Fox Talbot in 1844 had been practically realized in the taking of the portrait which formed the illustration. Not only, then, will these dark rays act to such an extent upon the sensitive plate as to enable us to produce images by their aid, but they may be the means of causing trouble in quite an opposite direction; for if the sensitiveness of the plate depends upon the absorption of these rays by the silver salt, and the body upon which the light falls either partially or entirely absorbs them itself, it is obvious that little or no action would take place upon the photographic plate. To test this it is only necessary to write upon white paper with a solution of the same substance (quinine sulphate) that was used to make the dark region of the spectrum visible, and then to take a photograph, using the same screen that was previously employed to cut off all visible light, when upon development a strong image of the writing, "which was invisible to the eye on the paper," will be produced, owing to the sulphate of quinine having absorbed the ultra-violet rays, with the result that the writing is rendered as black on a white ground in the print from such a negative. We thus see that the absence of the se[illegible]m to the action of the substance itself upon them, might be the cause of serious trouble in photographing when the silver salt in use was mainly sensitive to them, or the light particularly rich in such. It is thus evident that the photographic rendering of certain bodies is influenced by the nature of the plate employed and the kind of light used in illuminating the object. We will suppose that a wash drawing has to be copied, and that it is illuminated by the light from an enclosed arc, and that the negative is made upon a wet collodion plate. Now the light itself is rich in ultra-violet, and the wet plate very sensitive in this region. The result is that a negative could be taken with a comparatively short exposure. If for the wash drawing we substitute our white paper with the invisible writing upon it "made with quinine sulphate" quite a strong image would be obtained upon the wet plate owing to the substance having absorbed those rays which produce a strong action upon the plate, with the result that the sensitiveness of the silver salt has been apparently destroyed in those parts, and a negative image of the writing which will show as dark upon a more or less white ground in the print, results. Sulphate of quinine, however, is not the only body which behaves towards light in this way. Chinese white is a notable example and in the case of drawings in which this is used and the photographs taken under the conditions enumerated above, the effect is either to produce a black or a very degraded white. Owing to this difficulty other whites have been introduced, but unfortunately bodies are present as well, which may complicate matters by setting up chemical action, that may result in the white assuming a tint which is photographically very non-actinic. That this is the case can be very readily understood when we come to consider the pigments with which drawings are made and their close proximity and admixture with the white itself. Then, again, the medium with which the white is ground may exert some influence, and from some experiments made, this appears to be the case, as pure oxide of zinc photographs differently according to the method used in preparing the pigment. If we use other sources of light for the illumination, such as daylight or the open arc, again the results differ, so that the only really satisfactory test as to the photographic value of one of these pigments, is to make negatives under precisely those conditions that obtain in practice. But even then we shall only gain information as to how the white would photograph when used under ideal conditions; it will not tell us what the result might be were some other substance present in so small a quantity as not to visually alter its colour and yet photographically it might do so to a considerable extent.

EXPOSURE TABLE FOR APRIL. The calculations are made with the actinograph for plates of speed 200 H and D, the subject a near one, and lens aperture F/16.

Day of the Month.	Condition of the Light	Time of Day: 11 a.m. to 1 p.m.	10 and 2	3 p.m.	Remarks
April 1st	Bright	10 sec	13 sec	15 sec	If the subject be a general open landscape take half the exposures given here
,, ,,	Dull	25 ,,	27 ,,	3 ,,	
April 15th	Bright	·09 sec	12 sec	1[illegible] sec	
,, ,,	Dull	·21 ,,	25 ,,	28 ,,	
April 30th	Bright	08 sec	1 sec	12 sec	
,, ,,	Dull	19 ,,	2 ,,	24 ,,	

PHYSICS.

By Alfred C. G. Egerton, B.Sc.

VAPOUR PRESSURE.—When a substance is situated in an enclosed space there is a certain pressure set up within that space, owing to the tendency of the substance to vaporise. At any particular temperature an equilibrium is set up between the molecules leaving the surface as vapour and those condensing back on the surface as liquid or solid. As the temperature rise[illegible] the vapour pressure increases. Ice at 0° C. has a vapour pressure of 4·6 millimetres of mercury; ice at 10° C. about tw[illegible] millimetres; water at 100°, seven hundred and sixty millimetres. When the vapour pressure is the same as the external pressure, then the liquid boils; thus water boils at 100° when the barometer stands at the normal pressure of seven hundred and sixty millimetres. If the vapour pressure of a solid is greater than that of the external pressure, then the solid will vaporise without liquefying. An example of this is solid carbon dioxide, which has a vapour pressure, at so low a temperature as [illegible] greater than the atmospheric temperature, and goes over into gaseous carbon dioxide without liquefaction. Now gold boils at a temperature about 1000° C., that is to say, its vapour pressure is seven hundred and sixty millimetres at its boiling-point. As the gold cools, so its vapour pressure decreases and becomes so small that, at ordinary pressures, the vapour pressure is undetectable. It would be very interesting if the vapour pressure curves of metals could be carried down to very small values; the shapes of the curves would no doubt show whether the molecules associated as the temperatures decrease and the molecules of the metal become larger and heavier. It is known that in solution in mercury the molecules of most metals are simple atoms. It is difficult to conceive of iron, brass and common metals of that sort having a definite vapour pressure at ordinary temperatures and losing weight gradually; the effect is so small as to be undetectable by known means; and it is possible for a crystalline material of homogeneous composition that the molecules are so closely packed that the vapour pressure is absolutely nil, and no molecules whatever are able to leave the surface. When the substance is definitely crystallised and when the molecules possess so little kinetic energy that they cannot leave the surface, one would expect the vapour pressure to become zero. The vapour pressure of mercury has been measured at temperatures below 0° C. and has a very small value (·0008), but the pressure of the solid mercury is so small as to be unmeasurable. Vapour pressures of less than a hundred-thousandth of a millimetre cannot be measured as yet.

The methods of measuring small vapour pressures may be sub-divided into two main classes—dynamic and statical. The former class contains such methods as depend on the passage of some inert gas over the material under investigation and estimation of the amount carried over in a certain time. The second class measures directly the actual pressure set up by the vaporising substance. Some have used a very thin copper vane dividing a vessel into two chambers. Into one chamber the substance is introduced and the two chambers are then evacuated and closed; any difference of pressure is then measured by the deflection of the copper vane, such deflection being detected by causing light falling on the copper vane to interfere with the waves of another beam of light. Another method, employed by Dewar and others, depends on the change in rate of action of a "radiometer" as the pressure is altered. A radiometer is an instrument which consists of a light vane mounted within a fairly high vacuum—heat waves falling on one side of the vane, heat that side and increase the motion of the gas molecules in its neighbourhood and the vane is repelled away from them. Sir William Crookes discovered this action and the experiments led him later to the study of electric discharges in high vacua and the discovery of the cathode rays. Lord Rayleigh devised a sensitive manometer to measure small differences of pressure—by tilting the manometer, the levels of liquid in the two limbs can be brought so as just to touch two very fine points—the amount of tilt being measured by reflection of a spot of light from a mirror. A method of measuring low pressures of great ingenuity has been devised by Pirani. This consists of a specially constructed electric filament lamp of fine tungsten or platinum wire. The resistance of the wire in one such lamp is balanced against that of another. The one lamp is connected to the apparatus containing the substance the vapour pressure of which is required; this raises the pressure of the gas ever so slightly in the one bulb, and hence heat is conveyed away from the wire by the gas faster than from the wire in the other bulb and the [illegible] according as the temperature of the bulb alter. The method appears [illegible] of very limited application.

Next, the McLeod Gauge should be mentioned. Most low pressure measurements are made by means of such an apparatus, but the values obtained are only reliable under certain circumstances. This apparatus consists of a large bulb with a small tube connected to it. Gas in the large bulb can be pushed up into the small tube and measured under atmospheric pressure; from the change in volume from the large volume of the bulb to the small volume of the tube, the change in pressure from some low value to be found, to atmospheric pressure can be obtained from Boyle's Law "that the volume of a gas varies inversely as the pressure upon it, if the temperature is constant." However, the reliability of Boyle's Law at very low pressures is not absolutely certain, though experiments do tend to show that at low pressures the laws about gases still hold; and, further, the mercury itself has a certain vapour pressure which is entirely unmeasurable and neglected by this instrument. The walls of the tubes also are apt to condense vapours in their pores. Measurements of the pressure within X-ray tubes and electric lamps are made by means of the MacLeod gauge; the gauge gives an idea of the degree of vacuum attained, but is unreliable for absolute measurements of pressure.

The subject of vapour pressure is intimately connected with that of smell. The nasal nerves are capable of detecting a very small quantity of a substance; it is possible that one molecule of a substance, if it gets properly into contact with the sensitive portion of the nasal organ, might affect it perceptibly. The quantity of a gas, such as bromine, which is detectable is very small indeed, and the pressures of vapours detectable by smell are smaller than can be directly measured. The effect is probably of a chemical nature—a loose combination, perhaps, is formed between the molecules of the vapour and the substances of the nasal organ—it is noticeable that the smells of all oxidising substances, when dilute, are practically identical, which seems to show that the effect produced by them on the nasal organ is similar. The sensitiveness of the nasal organs of animals is well established, and it is indeed marvellous to think that sufficient molecules which can be smelt are left behind by a person who has passed a locality perhaps an hour previous to the arrival of his dog!

There is much interesting work to be done in this direction, and I have thought it worth while to draw attention to it in this month's notes.

SEISMOLOGY.

By Charles Davison, Sc.D., F.G.S.

THE ORIGIN OF EARTHQUAKES.—In a lecture on "The elastic-rebound theory of earthquakes" (Univ. of California Publications, *Bull. of the Department of Geology*, volume VI., pages 413–444), Professor H. F. Reid discusses a theory of the origin of earthquakes which has long been known, and I believe generally accepted, in this country. The theory is that earthquakes are due to the friction caused by the sudden sliding of the rock-masses adjoining a fault-surface, that they are, therefore, merely passing incidents of secondary importance in the growth of faults. Professor Reid bases his account of the theory on the remarkable displacements of the crust along the San Andreas fault which gave rise to the Californian earthquake of 1906. He sums up the theory in the following terms: "1. The fracture of the rock, which causes a tectonic earthquake, is the result of elastic strains, greater than the strength of the rock can withstand, produced by the relative displacements of neighbouring portions of the earth's crust. 2. These relative displacements are not produced suddenly at the time of the fracture, but attain their maximum amounts gradually during a more or less long period of time. 3. The only mass movements that occur at the time of the earthquake are the sudden elastic rebounds of the sides of the fracture towards positions of no elastic strain; and these movements extend to distances of only a few miles from the fracture. 4. The earthquake vibrations originate in the surface of fracture; the surface [illegible] start at first in a very small area, which [illegible] became very large, but at a rate not greater than the velocity of compressional elastic waves in the rock. 5. The energy liberated at the time of an earthquake was, immediately before the rupture, in the form of energy of elastic strain of the rock."

ZOOLOGY.

By Professor J. Arthur Thomson, M.A.

AQUATIC VERTEBRATES OF SAHARA.—It seems strange to speak of the freshwater fauna of the great desert, but it is a reality and of very considerable geographical interest. Besides a crocodile (*Crocodilus niloticus*) and a turtle, there are eight Amphibians and ten fishes. The interesting point is this, as J. Pellegrin points out, that while the more northern part of Africa has a Palaearctic Mediterranean fauna, the aquatic vertebrates of the Sahara are distinctively Ethiopian.

ORIGIN OF GERM-CELLS IN SILK-MOTH.—Another instance of the early segregation of the future germ-cells has been found by Vaney and Conte in the development of the egg of the silk-moth. At an early stage, when the blastoderm has been formed and the germinal disc marked off, two large cells appear between the blastoderm and the yolk which seem to form the future germ-cells. The segregation is not so precocious as in some other insects (the harlequin fly, *Cecidomyia*, and Chrysomelid beetles), but it is nevertheless a good instance of the early separation of the germ-plasm from any share in body-making.

PEARL MAKING.—A. Rubbel has made a very careful study of pearl formation in the freshwater mussel, *Margaritana margaritifera*, and is against the theory that they are the sepulchres of parasites. He finds that they arise around particles of a yellow substance, which resembles periostracum. They originate in closed, single-layered sacs of epithelium, which are constricted off from the external epithelium of the mantle, and, like the mantle, are able to secrete all the layers of the shell. The pearls grow by the deposition of layer after layer on their surface. The coalescence of several pearl sacs leads to the formation of curious pearl conglomerates. What are called shell pearls are formed, to begin with, in the mantle, and become secondarily attached to the shell. They are to be distinguished from shell concretions, which are due to intruded foreign bodies and show no concentric layering. Besides rejecting the parasitic theory of pearl formation, Rubbel calls attention to an overlooked fourth layer in the shell. It is a clear intermediate layer, dividing the nacreous layer into an outer and an inner stratum; it is particularly clear at the muscle insertions, but it occurs in other parts of the shell and in the pearls.

THE TURTLE'S EGG-LAYING.—S. O. Mast gives an interesting account of the behaviour of the Loggerhead Turtle in depositing its eggs. He watched the process on Loggerhead Key, Florida, in the month of July. The animal came straight out of the water about seven o'clock in the evening and proceeded directly up the beach for fifty or sixty feet. There seemed to be no selection of a place for the nest. By moving the posterior part of the body from side to side, and by throwing out the sand sideways and forward alternately with the hind flippers, she dug a trench four feet long and nearly ten inches deep in the middle. In this trench in a very complicated way she made a cylindrical hole nearly as deep as the length of the hind flippers. Into this hole the eggs were dropped—perhaps a hundred altogether. Noise and gentle touching did not cause any interruption. After laying the eggs the turtle covered them up, filling the trench as well as the hole. "This completed, she returned to the sea and entered only a few feet from the spot where she came out. On the way down the beach I stood on her back and she carried me (165 lbs.) apparently with but little effort." The turtle under observation was out of water forty-two minutes, spending three in reaching the nesting-place, four in making the trench, eight in digging the hole, twelve in laying the eggs, and fifteen in filling up, smoothing over and getting back to sea. The rate of locomotion on land is about half a mile an hour.

BORING BIVALVES.—For a long time there have been two theories in the field with regard to the method by which Pholads and other bivalves bore their burrows. According to one theory the boring is at least partly due to an acid secretion; according to another theory it is mainly accomplished by mechanical means. R. [illegible] has studied *Zirphaea (Pholas) crispata* and *Saxicava rugosa*, at St. Andrews, and comes to the conclusion that the boring is in these cases entirely mechanical. The *Zirphaea* works in two ways—sucking and scraping: "it might be described as a combination of a nutmeg-grater and a vacuum cleaner." The foot is extruded; a wide gap appears between the foot and the mantle; the mantle becomes fully extruded, and then rotatory movements begin. The shells consist of aragonite—harder than the usual calcite—and this must help in the boring.

DISCHARGE OF SPERMATOZOA IN FRESH-WATER MUSSEL.—Oswald H. Latter gives an account of this process as he saw it in May of last year. A specimen of *Unio pictorum* emitted from the exhalant aperture a fine double stream of milky substance, which rose nearly to the surface of the water and then fell as a diffused cloud. The whole of the water in the aquarium became cloudy and the emission continued for some hours. It appeared to be under control, for a slight shaking of the floor was followed by a cessation of the streams though the ordinary exhalant current of water appeared to continue without interruption. The liberated material consisted of [illegible] of sperm-balls, revolving and swimming like Volvox, gradually breaking up into the component spermatozoa, [illegible] exhibited astonishing activity, sustained below a [illegible] seven hours after liberation.

THEORY OF GALLS.—Jules Cotte makes some very interesting remarks on the origin of "zoocecidia"; that is to say, galls made by animals. He points out that there is often a striking structural resemblance between the animal-made gall and the plant-made gall; that animals far apart from one another seem able to make very similar galls; that the same animal produces very diverse galls; that an animal which causes galls at one place or at one season may be inoffensive at another; that there is sometimes a puzzling disproportion between the dimensions of the gall and the number of alleged producers; that some galls continue to grow after the parasites have disappeared, and that others are formed before the ovum of the parasite has been hatched. All this leads up to the theory that many so-called animal-made galls are due to moulds or bacteria or the like introduced by the animal. The insect or mite is a carrier of a vegetable infection, and in many cases the zoocecidia are demonstrably associated with fungoid growth. Cotte does not deny that there may be true zoocecidia, but he thinks that many are more accurately described as myco-zoocecidia or phyto-zoocecidia.

SOLAR DISTURBANCES DURING FEBRUARY, 1912.

By FRANK C. DENNETT.

February has yielded a much better proportion of dates when telescopic scrutiny of the Sun was possible than either of the two previous months. Only on three days (8th, 15th, and 16th) did he escape observation. The central meridian at noon on February 1st was 108° 45'.

No spots were observed during the month, though there were some faculic disturbances as shown on the diagram.

On February 2nd and 3rd, a group within the eastern limb occupied the area between longitudes 27° and 37°, and south latitude 5° and 6°.

On the 17th and 18th a facula within the eastern limb was situated at longitude 180°, south latitude 9°.

On the 24th some faculae near the western limb must have been about longitude 245°, and near to the equator, but were not measured. Also on the 24th and 25th a faculic disturbance was noted within the eastern limb, a little over 10° south latitude and near longitude 88°.

On the 27th a small facula was situated at longitude 205°, north latitude 20°, and so near the north-western limb. A larger and paler disturbance, containing a dull patch near its eastern end, was also approaching the western limb, and situated between longitudes 190° and 200°, south latitude 6° to 8°.

On the 29th a facula, doubtless that seen on the 17th and 18th, was approaching the western limb in south latitude.

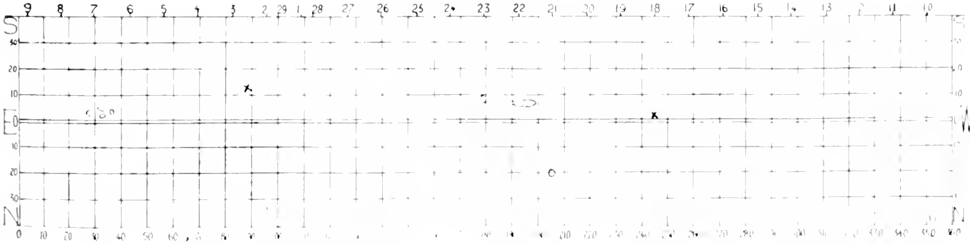
Mr. E. W. Maunder, writing at the desire of the Astronomer Royal, kindly tells us that "two small faint spots in the middle of a little group of faculae were photographed at the Cape Observatory on December 18th last. One of the spots remained to the next day, when it was smaller but darker. It was photographed at Greenwich on December 19th. The positions as measured were:

Dec. 18.	Long. 295°·3	...	Lat. N. 22°·7
„ 18.	„ 293°·5	...	„ N. 24°·2
„ 19.	„ 295°·1	...	„ N. 23°·3"

This district would cross the Sun's central meridian only a little after midnight on December 21–22. It almost appears as if it were the starting of a new cycle of solar activity, and also interesting as occurring in the northern hemisphere as was foreshadowed.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, F. E. Peacock, W. H. Izzard, and the writer.

DAY OF FEBRUARY.



REVIEWS.

BIRD-MIGRATION.

The Migration of Birds. By T. A. Coward. 137 pages. 4 illustrations. 6½-in. × 4¼-in. (The Cambridge Manuals of Science and Literature.)

(Cambridge University Press. Price 1/- net.)

To write on the subject of bird migration within the limits of a small manual is an act of some courage, but Mr. Coward may be congratulated on the success with which he has accomplished his work. It is however significant of the state of mind which the subject seems to induce to find the penultimate chapter headed "Suggestions and Guesses"; reliable and definite conclusions seem still far to seek. In the earlier chapters a good and clear account is given of theories which have been promulgated, old and new, and many of the facts and incidents ascertained by observers in different countries—the British Isles, Europe and North America—are stated and drawn upon in illustration. These are full of interest, even although sometimes more like curiosities of natural history than anything else. Ornithophaenology, "the accumulation of substantiated observations and facts," Mr. Coward remarks, "will not prove everything" (page 6), but it might be added that without these, properly co-ordinated and classified, nothing can be proved. Such systematic work would prove, in the end, more useful and satisfactory than theories and speculations.

A good bibliography is given, and although it is stated that a full one has not been attempted, yet it is curious to find mention of only two of the long and still continued series of "Reports on the Movements of Birds in Scotland," and none at all of the British Association "Reports on the Migration of Birds" (1880-1887), or of the current series of reports published by the British Ornithologists' Club.

H. B. W.

CHEMISTRY.

The Chemistry of the Radio-Elements.—By F. Soddy, F.R.S. Monographs on Inorganic and Physical Chemistry. 92 pages. 8¾-in. × 6-in.

(Longmans, Green & Co. Price 2/6 net.)

The process of specialisation in different branches of Chemistry has reached such a stage that no one can hope to keep in touch with the whole of the science. Moreover, even in the special branches, the literature is so widely scattered throughout scientific journals all over the world, that important contributions may readily escape notice. These drawbacks have already been met in the case of biological chemistry by the publication of a valuable series of monographs, the object of which has been to summarise the present state of our knowledge of the particular subject, and to serve as a sign-post to those who are travelling in the same direction.

This idea has now been extended, and in the present monograph we have the first of a series intended to deal in a similar manner with different branches of inorganic and physical chemistry, each to be written by an acknowledged authority.

In the book under consideration we have an excellent outline of the new subject of radio-chemistry, and a summary of the results of the most recent investigations. After a general description of the nature and phenomena of radio-activity, sections are devoted to each of the radio-active elements, including the interesting cases of potassium and rubidium, and the book concludes with a table of references, an index, and a chart illustrating the genetic formation of the elements successively produced in the disintegration of uranium, actinium, and thorium.

In a future edition it would be an improvement if the references were classified under their respective headings. With this exception we have nothing but praise for the book, which may be heartily recommended both to the research student and to the general reader who has some slight knowledge of chemistry and is interested in its latest developments in this direction.

C. A. M.

A Text-Book of Inorganic Chemistry.—G. Senter, D.Sc., Ph.D. 583 pages. 90 illustrations. 7½-in. × 5-in.

(Methuen & Co. Price 6/6.)

The appearance of new text books on inorganic chemistry has now become so perennial, that on meeting with a fresh addition to the list one's first thought is to discover why it was written. In the present instance, the answer and the justification are not far to seek, for the increasing application of physical methods to chemistry, which has led to such striking developments of the latter science, has rendered both desirable and necessary the writing of an elementary text-book dealing with the subject from modern points of view. In this aim the author has been completely successful, and his book should meet with a warm welcome in many quarters. It covers more than the ground usually included in the examinations for the London B.Sc., but at the same time cannot be described as a "cram-book"; for practical work and the application of general theory to particular instances are skilfully interspersed throughout its whole course. For instance, the physical methods of determining the molecular weights of substances in solution are described early in the book, and their use is continually illustrated in the succeeding pages.

As those who are acquainted with Dr. Senter's book on physical chemistry would anticipate, an immense amount of information is conveyed in the clear yet concise words of the born teacher, while diagrams are introduced wherever necessary to the text. In short, the book marks a great advance upon the text-books of only a few years ago, which described masses of more or less isolated facts in the arbitrary manner that was inevitable, since important links which bound them together had not yet been discovered.

C. A. M.

GEOLOGY.

Geological and Topographical Maps: Their Interpretation and Use.—By A. R. Dwerryhouse, D.Sc., F.G.S. 133 pages. 90 figures. 9-in. × 6-in.

(Edward Arnold. Price 4/6 net.)

This book fills a gap in the technical literature at the disposal of the teacher of geology, and is therefore assured a wide welcome. It opens with a good general account of topographical maps and their interpretation, in which one is pleased to note an insistence on the importance of the true scale in drawing both topographical and geological sections. In teaching, however, it is often very difficult to present geological structure to students without some exaggeration of the vertical scale. True scale drawing should only be introduced after the elementary principles have been mastered. A useful summary of the characters of the various maps issued by the Ordnance Survey of this country is given with explanation of the system of numbering and method of ordering. The brief and necessarily sketchy chapter on some structural features of the earth's crust might have been expanded to some purpose.

The problem of the relation of geological outcrops to contour lines is treated as following from the general problem of the mode of intersection of two contoured surfaces, one of these being the surface of the ground, the other the geological stratum considered. The directions of V-shaped outcrops in valleys is deduced easily and naturally on this method. In succeeding chapters the complications due to inclined and folded strata, unconformities, overlaps, and faults, are dealt with; together with the methods of representing igneous and metamorphic rocks in plan and section. The principles thus brought out are then applied to the elucidation of geological history from maps, and some very instructive examples are given.

The concluding chapter gives some practical advice to geologists on the methods of conducting a geological reconnaissance. This should prove most useful, as many geologists have but slight acquaintance with topographical surveying, without which geological work in a little-known and unmapped country is not only more difficult but loses much of its value. This book seems to fulfill its purpose excellently and may be warmly recommended not only to students of geology, but also to civil engineers and others for whom the correct interpretation of topographical and geological maps is often essential.

G. W. T.

Secrets of the Hills, and how Ronald Read Them. By Sterling Craig, M.A., LL.B. 320 pages. 10 plates. Numerous Woodcuts. 8½-in. × 6-in.

(G. G. Harrap & Co. Price 3/6 net.)

In this book geology is genially expounded by a preternaturally wise doctor to a receptive and questioning schoolboy, Ronald. The scene is laid in Scotland, where Ronald is enabled to visit the lead mines of Leadhills, to dig and wash for gold in the same district, to descend a coal mine, and, in short, to sample many of the phases of the rich and varied geology of that favoured country. The author has managed to cover most of the field of modern geology. A simple method of question and answer is used throughout, but the more solid instruction is interspersed with picturesque accounts of Ronald's gold digging and other exploits, in such a way that the book should never pall with the right kind of boy reader. The author has taken great pains to get his facts correct and thoroughly up-to-date, and to that end secured the services of Dr. B. N. Peach, F.R.S., to read over his proofs and to make suggestions and corrections. There is consequently very little with which to find fault, a mistake such as "Unita" for "Uinta," repeated twice on page 157, and also on page 10, and an obvious misprint (page 265), being all that has attracted the reviewer's attention. The book is finely illustrated with plates, woodcuts, maps and diagrams, which might, however, have been numbered. The absence of an index is partly compensated for by a very full list of contents. Altogether this is a surprisingly interesting book, far in advance of other and older productions of its kind, and may be read with pleasure and profit by adult novices in geology as well as by the boys to whom it is primarily addressed.

G. W. T.

MATHEMATICS.

A New Algebra, Vol. II.—By S. Barnard and J. M. Child. 731 pages. 87 illustrations. 7½-in. × 5 in.

(Macmillan & Co. Price 4/-.)

This volume completes the school course of Algebra for the ordinary student—a third volume is in preparation to satisfy the needs of the mathematical specialist. It is written on the old lines, but it is brought up to date with chapters on approximate values and graphs. It is certainly a book to be recommended for the use of scholars; and the excellence of the examples should make it possible to be used by less capable students. The authors have written a book that goes far to defend the position they assign to Algebra in the scheme of education; they would have rendered that position less assailable if they had had the courage to do a little pruning—why, for instance, is Harmonical Progression allowed to cumber the ground? In our opinion the pure theoretical niceties of the proofs (especially in so-called "fundamental laws") are over exaggerated—the clearness of the numerical calculation in Section 293 is more valuable educationally than pages of abstract reasoning. We wish more attention had been paid to giving in true perspective the importance of different theorem and methods; why is not Professor Hill's proof of the exponential used? e is so important an actor in the world of mathematics that its entrance on to the stage should have been heralded by a flourish of trumpets; instead, we see it dragged on, clinging to the skirts of the Binomial Theorem.

L. W. D.

A Shorter Geometry.—By C. Godfrey and A. W. Siddons. 301 pages. 287 illustrations. 7½-in. × 5½-in.

(Cambridge University Press. Price 2/6.)

This contains the substance of the well-known "Elementary Geometry" by the same authors, rearranged in accordance with the views expressed in the Board of Education circular. The authors point out in their preface that the new book is eighty-seven pages shorter than the old one, and that nothing essential has been omitted. Like the Shorter Catechism, the book seems long enough for most youngsters, and we have nothing but commendation for the process of curtailment. For its size the book is remarkably massive, and should make a formidable missile.

METEOROLOGY.

Our Weather. By J. S. Fowler, F.R.Met.Soc., and W. Marriott, F.R.Met.Soc. 151 pages. 63 illustrations. 6 in. × 4 in.

(J. M. Dent & Sons. Price 1/- net.)

This little volume forms one of the series of Temple Primers, of which forty-five have now been issued. It is clearly written in a very interesting way by competent and experienced authors, and touching as it does on every branch of the subject it forms a capital manual in itself and an excellent introduction to larger works. The chapter on Phenological observations is a valuable addition, since this branch of Meteorological work is frequently passed over in text books. The illustrations are numerous and good.

J. A. C.

PHYSICS.

A College Text-Book of Physics. By A. L. Kimball, Ph.D. 692 pages. 610 illustrations. 8½-in. × 6-in.

(London: G. Bell & Sons. New York: Henry Holt & Co. Price 10/6 net.)

This book belongs to the class, now somewhat numerous, of which Ganot is the type, and it is an excellent example of that class. It is adapted to the needs of students taking the general first-year course in an American College, and contains all the Physics usually demanded as a preliminary to scientific professions in this country. It follows that mathematical reasoning is allotted a secondary place in the scheme of the book, and clear presentation of physical facts is aimed at throughout. The mathematical treatment is good as far as it goes, which is perhaps no further than would, to use a phrase of Sir J. J. Thomson's, "give a headache to a caterpillar." Thus Newton's formula for the velocity of sound is given without proof: in fact, the methods of the calculus are not employed, and the proof of the formula for acceleration of uniform circular motion is hardly as sound as it might be. Lenses are treated by the method of rays, and although the diopter is not introduced, convex lenses are taken as positive, and concave as negative. It is doubtful whether the formula and the rules given for using it are any easier for the indifferent mathematician than the old-fashioned treatment. There is an excellent section on "Fluids in Motion"; and it is surprising to find in a book with so many practical applications a treatment of machines in which friction and efficiency are disregarded. The chapters on "Heat" seem rather short. On the other hand, "Light," and particularly "Diffraction," obtains full attention. The book is well worth the consideration of teachers and students.

W. D. E.

Pyrometry. By C. R. Darling, F.I.C. 200 pages. 60 illustrations. 7½-in. × 5-in.

(E. & F. N. Spon. Price 5/- net.)

This little manual, which is based upon lectures given before the Society of Arts, deals, as its title suggests, with the measurement of high temperatures, above the range of the mercury thermometer. It gives clear descriptions, with illustrations, of the different types of pyrometric apparatus, and fully explains the principles upon which they are based, so that there should be no difficulty in understanding the way in which they are used.

The book is essentially of a practical character, and fills a distinct gap in the literature of applied chemistry. It will be found of the greatest assistance to all whose work involves the measurement of high temperatures.

C. A. M.

PREHISTORIC ARCHÆOLOGY.

Prehistoric Japan. [illegible] Neil Gordon Munro, M.D. [illegible] illustrations. [illegible]-in. × 6¾-in.

([illegible] Price 21/- net.)

[illegible] dated January 5th, 1908, but a [illegible] number of the copies were [illegible] Those who are interested in [illegible] will notice that the work has been [illegible] hundred pages are crowded with notes and [illegible] Palæolithic and Neolithic remains as [illegible] pottery; Bronze vestiges are also dealt with [illegible] chapters are devoted to Yamato remains. [illegible] deals with the prehistoric races themselves [illegible] some reproductions of good photographs [illegible] To the general reader, no doubt, the discussion [illegible] and social relations will prove attractive. Dr. Munro [illegible] very definite opinions, for instance, on the origin of clothing, and he says that notwithstanding the confusion which has arisen regarding its primary function there can be no question that the habit of dress originated in personal decoration. As a means to an end—namely, sexual selection—it is almost impossible to exaggerate the importance of personal embellishment in modifying, sustaining, or emphasising various characters of the race.

All the same, in his following sentence he seems to recognise the adoption of clothing for reasons of coquetry, for he alludes to the alluring motive of modern ball room costume. Dr. Munro's remarks on face painting may also be mentioned. Red appeared to be the favourite colour, but two black spots on the forehead were affected by the court nobility of both sexes till a few decades ago, not for embellishment, as were the patches of Europe, but as a sign of rank. The painted patterns also, judging from primitive images, show a likeness to those which were originally tattooed. We congratulate Dr. Munro on having produced a most useful and attractive book.

W. M. W.

PSYCHOLOGY.

A Text Book of Experimental Psychology, with Laboratory Exercises.—By Charles S. Myers. 2 vols. Second Edition. Part I: Text-book. 344 pages. 1 plate and 24 figures and diagrams. Part II: Laboratory Exercises. 107 pages. 42 figures and diagrams. 8¾-in. × 5¾-in.

(Cambridge University Press. Price 10/6 net.)

The first edition of Dr. Myers's work was published some three years ago and at once took a place in the first rank of text-books of this class. Of it a critic, writing in one of the leading American journals, said: "It is a question whether any single book contains as much information as does Myers's text book." Both in range and quality, both in method of arrangement and in presentation, the work was admirable. The new and enlarged edition brings the treatment up to date and is worthy of the heartiest commendation. Although it is not primarily meant for the general reader, although the discussion is too thorough to afford light and easy reading, yet all those who appreciate the genuine scientific spirit, all those who feel the charm of living touch with contemporary investigators, will turn to Dr. Myers's work with profit and pleasure. There must, however, arise some sense of disappointment that so large a proportion of the space at his command is devoted by the author to sensation and to what may be termed the lower and more elementary factors in experience. But this is inevitable in any attempt to apply in psychology the touchstone of experiment. Methods of dealing with the more complex mental products and processes have only recently been devised and are on their trial. Dr. Myers has added in this edition a new chapter on Thought and Volition, in which the question of imageless thought is briefly considered. We trust that arrangements have been made by which Dr. Myers will be enabled to bring his admirable work up to date at comparatively short intervals. If this be done it will continue to retain the position which it has won.

C. Ll. M.

ZOÖLOGY.

Social Life in the Insect World. By J. H. Fabre. Translated by Bernard Miall. 327 pages. 14 illustrations. 9-in. × 6-in.

(T. Fisher Unwin. Price 10/6 net.)

This series of observations—by that well-known French entomologist, described by Darwin as an "inimitable observer"—makes most fascinating reading. By careful and patient watching, renewed season after season, he endeavours to throw light on many interesting points—as, for example, the wonderful power possessed by the female Emperor moth of attracting the males from long distances. Several chapters are devoted to the very peculiar habits of the Praying Mantis, while various other insects are similarly dealt with. The book is written in an exceedingly attractive style, and the photos by which it is illustrated complete an altogether delightful volume.

A. A.

A Junior Course of Zoology.—By the Late A. Milnes Marshall, M.D., D.Sc., M.A., F.R.S. 515 pages. 94 illustrations. 7¾-in. × 5¼-in.

(Smith, Elder & Co. Price 10/6 net.)

No one who in the old days used "Marshall and Hurst" to their advantage can fail to welcome the appearance of the seventh edition, which Professor Gamble has prepared for the press. At the same time it may not be amiss for one who has had many years' practical experience of the book to point out its greatest failing.

This is really nothing to do with the subject matter but with the method in which the very useful figures are labelled. If only the actual names of the parts had been written on the diagrams instead of various letters for the meaning of which the student has to turn, often to another page, much time, trouble and annoyance would be saved. The only redeeming feature is that the letters used refer to English words, whereas in some of the text books which borrow foreign clichés the trouble is augmented. The present writer was, in fact, so impressed with the need for reform in this matter that in any biological illustrations which he has prepared for students' use he has always had the full name of the parts inserted. In these days of cheap line process reproduction the extra cost need not be considered.

W. M. W.

NOTICES.

PHOTO-MICROGRAPHY.—On Monday, May 6th, Mr. Edgar Senior will begin a course of six practical demonstrations on Photo-micrography at the South Western Polytechnic Institute, from 7.30 to 9.30 p.m.

At these demonstrations special attention will be given to the photographing of etched surfaces of metals and alloys (Metallography), but the course will also be arranged to suit the requirements of students of Geology, Botany, and so on, and of those wishing to use their own microscopes to obtain photographic records of objects.

It is advisable that students joining this course should possess an elementary knowledge of photographic manipulation. Fee for course, 2s. 6d.

A NEW SCIENTIFIC QUARTERLY REVIEW.—On the first Tuesday in April, Messrs. Constable and Company will publish the first number of *Bedrock*, a quarterly review of scientific thought. The editorial committee consists of Sir Bryan Donkin, Professor Poulton, Mr. Archdall Reid, and Professor Turner, while the acting Editor is Mr. H. B. Grylls. *Bedrock* is an attempt to provide an arena in which thinkers possessing a common knowledge but divergent opinions can meet and endeavour to thrash them out. We sincerely hope that the editors of the new review will find ample justification for their belief that there are few scientific or social problems of which the solutions would not be hastened by the provision of such an arena.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MAY, 1912.

AN IMPROVED TOEPLER PUMP.

By H. J. GRAY.

WHEN working with a Toepler pump in the production of high vacua, the necessity to refill the mercury reservoir from time to time is a source of inconvenience. To remedy this defect the writer has successfully adopted the device described in the following paragraphs.

The principle will be evident from Figure 183, which represents the essential features of a typical form of Toepler pump. Instead of a single reservoir, two equal mercury-containers are used. These, it will be seen, are connected to the branches of a Y tube fixed in an inverted position. Each branch should be tapped or, as a substitute, strong but easily operated spring clips might be used on the india-rubber connecting tubes. A screw clip would be too troublesome.

The receptacle, C, containing the end of the eject tube, has a tubulure at the side, into which is fixed a perforated rubber cork, having one end of a bent glass tube passed through it. To the lower end of this is fixed a short rubber tube and glass jet. Let the reservoir, A, be filled with mercury, raised and supported in an appropriate manner. The tap, D, being open, the mercury passes through the pump in the ordinary manner and ultimately reaches the vessel, C. Overflowing through the bent glass tube it falls into the second reservoir, B, which is supported immediately beneath, the tap, E, being kept closed. Thus one reservoir is always filling automatically, while the other is discharging. When A has become empty it is the work of a moment to raise the mercury for another fall. Simply reverse the position of the reservoirs, always opening the tap communicating with the full one and closing the other. It is not necessary to fit a tap to the vessel C, since the mercury is always flowing through the bent tube except for the moment while the reservoirs are being changed, when the short rubber tube may be closed by pressure between the fingers.

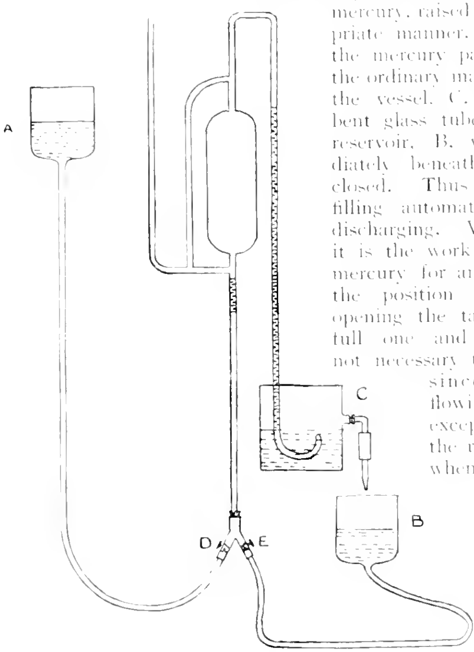


FIGURE 183. An Improved Toepler Pump.

A three-way tap may be substituted for the tapped Y-piece with equally good results. It should have a bore of about two millimetres, and may be provided with a mercury trap if considered advisable.

THE SUNDEW: A BRITISH INSECT-EATING PLANT.

By E. HALFORD DUDLEY BUNTON AND PHILIP J. BARRAUD, F.E.S.

Those who are fond of dabbling in old books as well as searching out flowers in the field, will find the subject of our paper thus described by the botanist Ray: "Sundew, or Rorella, of which the distinguishing marks are: the leaves are fringed all round with reddish bristles, to which little drops, as it were of dew, stick, etc."*

Curiously enough, this keen old observer does not mention the fact to which most people owe their interest in the plant, namely, that it is carnivorous.

It is customary to make the rough generalization—inaccurate often in detail, though true in principle as so many generalizations are—that plants can feed on inorganic substances while animals need organic food. This may be briefly explained as follows: We are all familiar with the old division of the world into animal, vegetable, and mineral. If we include under mineral everything, such as air and water, which is neither animal nor vegetable, we shall have the matter clear. Organic is animal and vegetable, inorganic is everything else. Animals, then, need organic food; plants can, with some exceptions, do without it, from which it follows that, whereas plants could live without animals, animals could not live without plants.

But if we turn to the Sundew we are immediately confronted with an exception, a plant, which has so far forgotten what is the usual nature of plants, as to feed on meat.

The time has gone past when science was allowed, or indeed expected, to ask "why," but it is our duty to ask "how."

Now it will be noticed that the three British genera of insect-eating plants, *viz.*, *Drosera* (Sundew), *Pinguicula* (Butterwort), and *Utricularia* (Bladderwort) live in marshy districts. It is probable that to live in marshes and stagnant pools is to be in a place where starvation is always a possibility. These plants have found a method of getting out of the difficulty by adopting, partially or entirely, a new diet. But to digest new food materials new methods were necessary, and it is a curious fact that the Sundew manages to digest the animals it captures in a way not unlike that in which we ourselves digest food.

From this we may deduce the interesting fact that a similar problem is solved in a similar way. Such a condition is of special interest at the present day, because of the various evolutionary theories that are being put forward. It is said by some writers that every living thing has in it many possibilities which are not always fulfilled, and that, given the same circumstances, it is possible for living things, though of widely different classes, to solve the same problems in precisely the same way. The Sundew is an instance which might be adduced as a case in point. There are, of course, many objections to the theory.

Let us now consider the Sundew in detail. The photographs here reproduced were all taken from the same leaf at intervals and are enlarged twice natural size.

It will be seen (from Figure 184) that the leaf is furnished with a large number of specialized hairs. Each one bears at the extremity a gland which is very sensitive to the slightest touch, and which secretes a drop of sticky fluid. It is possible that insects when in want of moisture visit the plants in the hope of satisfying their thirst, being attracted by the drops of fluid resembling dewdrops, but when once they have touched the leaf they are usually unable to disentangle their limbs from the sticky substance. The insect in its endeavours to get free is almost certain to touch some of the other hairs, and these help to hold it until it is hopelessly entangled. If we watch very closely, we shall see in a few moments that the hairs, which have been touched, begin to bend inwards towards the middle of the leaf carrying the insect with them. Soon the unfortunate captive is brought into contact with the next row of hairs. These in turn bend, carrying it further inwards, until it is in the middle of the leaf and in contact with the short hairs of the central disc. (See Figures 188–191.)

Then from the last-named some sort of impulse radiates to all the other hairs, and soon the insect is clasped from all sides and enveloped in the secretion. (See Figures 192–195.)

The length of time which this takes varies considerably, from under one hour, to as many as twenty-four or even longer, and depends on the age and consequent vigour of the leaf, the temperature of the atmosphere, and many other circumstances.

An insect, however, generally dies in from fifteen to thirty minutes owing to its breathing tubes (spiracles) becoming clogged with the secretion.

A leaf usually remains closed over a fly for some days, then slowly re-opens, exposing to view the harder parts of the insect, which have not been digested. All secretion then dries up for a time and the undigested parts drop off, or are blown away. Then the leaf again begins to secrete in readiness for another meal.

It is frequently stated that it is not possible to deceive this plant, and that it will take no notice of little pieces of stone or similar objects if they are placed on the hairs. This, however, is not always

* Ros solis seu Rorella, cuius notae folia setis rubentibus circum quaque fimbriata quibus guttulae velut roris adhaerent, and so on.—Ray, "Methodus Plantarum."

FIGURE 184.

FIGURE 185.

FIGURE 186.

FIGURE 187.

Figure 187 is the same as Figure 186 seen from the side.

FIGURE 188.

FIGURE 189.

FIGURE 190.

FIGURE 191.

Figures 189 and 191 are side views of the leaf as it appears in Figures 188 and 190.

FIGURE 192.

FIGURE 193.

FIGURE 194.

FIGURE 195.

Figures 193 and 195 are side views of Figures 192 and 194.

The Leaf of a Sundew (*Drosera*) taken at successive intervals when "feeding" on a Fly. Twice life size.
The Fly was of a species a little smaller than the common House-Fly.

[illegible]

the [illegible] piece of stone, paper, wood [illegible] sufficient to cause movement, provided these [illegible] enough to penetrate the secretion [illegible] the gland, but the action is often slower and less complete than if meat or insects were [illegible]. Raindrops, however, do not seem to cause movement; on the other hand, the leaves are very much affected by the application of a finger.

We have so far been considering the "indoor" side of the Sundew; let us try for a few minutes to search for it out in the sunshine. To show the plant association in which it lives we may give a picture of a favourite hunting ground. This is a marshy piece of ground through which a stream flows, shut in by steeply-rising rocks, in the hollows of which grow oak trees. The essential point for our purpose is the absence of cultivation. Round the marsh there grow many of the sweet scented plants, mint, and marigolds, "which go to bed with the sun and with him rise weeping," and other flowers of middle summer, as Perdita calls them. There are some low bushes of sweetgale and tufts of heather. To drain off the excessive water, a ditch has been cut through the peat. On the banks of this grow Meadow Sweet, Purple Loosestrife and Butterwort. The marsh itself through which this ditch runs is a vivid green tinged with red from the Bog Moss which fills it. Here the Sundew grows in great abundance, and the tinge of its leaves adds to the colour of the Sphagnum. In one corner, where the marshy character gives place to swamp, the cotton grass becomes prominent, then reeds and horsetails and, finally, on the open water, water lilies float.

A COLOSSAL REINFORCED CONCRETE STATUE.

By FRANK C. PERKINS.

The accompanying illustrations show the remarkable reinforced concrete Indian statues of Lorado Taft's design, as unveiled in 1911 at Eagle's Nest Bluff, Oregon, Illinois. This colossal statue of the famous Indian chief "Blackhawk," overlooking the Rock River, Illinois, was presented to the people of the state. It measures forty-two feet high with a base of six feet, and was erected on a natural rocky bank two hundred and fifty feet high, overlooking the river. The total height of the concrete statue measures forty-eight feet.

A French reinforced concrete statue was recently erected in Espaly, Loire Department, France, and is also entirely made of reinforced concrete, the pedestal and the figure of St. Joseph together being seventy-two feet. A three-story tower, twenty-five feet in diameter, and 24·4 feet high, forms the base. Within this base are seven columns in a circle, which carry the weight of the statue itself.

The figure, weighing eighty tons, measures forty-eight and a half feet in height, and is composed of a framework of reinforced concrete about which the outside mantle is fitted. The framework in the main is made up of a vertical shaft with a tube at the top which forms the axis for the head. There is a series of nine horizontal platforms in the various sections of the figure which supports the exterior coating of the figure. It is stated that the statue was moulded on the ground and fitted around the framework, all traces of joints being effaced by a proper finish, so that the entire statue seems to be a single structure.

Figure 196.
In course of Erection.

Figure 197.
The Mould of the Head.

Figure 198.
The Head.

Figure 199.
The finished Statue.

The Concrete Statue at Eagle's Nest, Bluff, Oregon.

A SIMPLE METHOD OF FINDING THE RADII VECTORES OF A COMET'S ORBIT.

By THOMAS ASHE CREGAN.

To illustrate this method I have taken Comet 1908, *c.*, the positions of which are those given by Professor Kobold in the *Astronomische Nachrichten* for Berlin mean midnight on the 2nd, 4th and 6th October, 1908, the corresponding Greenwich mean time being 11 hours 6 minutes 25 seconds. According to the *English Mechanic*, Vol. LXXXVIII, No. 2274, page 282, these positions are subject to a correction of 90 seconds to add to the Right Ascension and 1′·3 to subtract from the Declination: they then are as follows:

	2nd.	4th.	6th.
Comet's R.A. ...	313° 51′ 0″	308° 10′ 30″	303° 34′ 15″
Do. Dec. N....	70° 4′ 48″	67° 26′ 42″	64° 30′ 42″

The corresponding places of the sun being

	2nd.	4th.	6th.
Sun's R.A. ...	188° 34′ 21″	190° 23′ 26″	192° 12′ 32″
Do. Long. ...	189° 20′ 20″	191° 18′ 34″	193° 16′ 52″

Find the earth's orbital motion between the observations, that is, from the 2nd to the 4th and from the 4th to the 6th, and resolve each separately into two components, one a motion almost directly away from the comet, the other a motion in the same direction as that in which the comet, whose motion is retrograde, is moving. Since the comet is at a *finite* distance, its positions are dependent upon our point of view, that is, upon the place of the earth in her orbit. The Declinations must therefore be reduced to the mean Equinoctial and the Right Ascensions corrected for the angular difference between the directions of the first point of Aries as seen from the sun and from the earth, at the instant of observation. Also, with the components of the earth's orbital motion we must reduce the places of the two last observations to that of the first. The corrected and reduced places of the comet then are:—

	2nd.	4th.	6th.
R.A....	305° 16′ 30″	295° 21′ 16″	286° 28′ 30″
Dec....	71° 13′ 48″	68° 51′ 24″	66° 10′ 42″

And these referred to the plane of the Ecliptic give—

	2nd.	4th.	6th.
Geoc. Long. ...	286° 44′ 32″	282° 58′ 42″	279° 2′ 50″
Geoc. Lat. ...	49° 49′ 32″	46° 32′ 47″	43° 14′ 42″

From the foregoing data we next find the value of r at the first observation, for the angle P = 97° 24′ 12″ and of the two sides, PS′ = 40° 10′ 28″ and PS = 90°, whence SS′ is found to equal 1·57937 in parts of radius, and this is the value of r at *unit distance*. Now, of the three bodies with which this problem deals, *viz.*, sun, earth and comet, since the sun may be considered as stationary, it is evident that if we eliminate the effects of the earth's orbital motion in the interval between the observations from the angle P, we will have the values of P′ and of P″, and a simple proportion will give the values of r′ and r″, assuming for the present that the comet's motion is uniform, therefore

97°·403 : 96°·0694 :: 1·57937 : 1·55745 r′

Also

96°·0694 : 94°·59526 :: 1·55745 : 1·533841 r″

These are the values of r′ and r″, determined from that of r on the supposition that the comet's motion is uniform. This, we know, is not the case. The comet's motion is increasing; therefore r′ and r″ will both be too great by a quantity equal to the second difference of r, r′ and r″, which must be subtracted from the values just found. We have next to find "c," or the length of the arc of the orbit which the comet appears to describe between the first and last observations. Using the same formula, we have: P = 7° 41′ 42″, PS′ = 40° 10′ 28″, PS = 46° 45′ 18″, which gives S′S in parts of radius as ·142097, to which we must add ·00227 the second difference already found, and we obtain finally:—

r = 1·57937, r″ = 1·53157, c = ·144367

all at *unit distance*, with which to satisfy the equation,

$$2t = \frac{365\frac{1}{4}}{12\pi}\left\{(r + r'' + c)^{\frac{3}{2}} - (r + r'' - c)^{\frac{3}{2}}\right\}.$$

$$2t = 8 \text{ days also } \frac{365\cdot 25}{37\cdot 6992} = 9\cdot 6885\text{; therefore,}$$

$\frac{8}{9\cdot 6885} = \cdot 8257$ which is the number that we have to obtain by trial values of r, r″ and c, in order to satisfy the equation. Using figures to the fourth decimal place only, I find that 1·0537 gives ·8255, which satisfies the equation within ·0002; therefore the radii vectores of the comet's orbit on the dates computed are:

	1·6641	1·6389	1·6137
Professor Kobold gives....	1·6642	1·6388	1·6136

To find the corresponding distances of the comet from the earth, or the values of D, D′ and D″. In the triangle CSE, formed by the comet, sun and earth, we have found the side CS, which equals r, and SE = R, is known from the Greenwich date of the observation, we have therefore to find the angle at E. Taking the comet's R.A. at the first observation, *add* to it the angle ♈ SE and reduce the observed declination to the apparent equinoctial of the date, we then have

corrected R.A. = 322° 25′ 21″; reduced Dec. = 71° 49′ 3″,

and these referred to the plane of the Ecliptic give the angle at E = 104° 16' 9" and the angle at S = 39° 41' 56", therefore D = 1·09907 in parts of radius.

While D' and D'' may be found in like manner, taking care to add to the corrected R.A., the value of the earth's orbital motion in the interval, it is not necessary to undertake this labour, since we only require to know the change in the value of the angle at E. Indeed, since D' is not involved in the computation of the elements of the orbit, it may be neglected.

To find the angle at E at the second and third observations, we have seen that the difference between P and P' = 1° 20' 2". Now the angular motion of the earth in the ecliptic in the interval is 1° 58' 16"; therefore, the difference between these two, subtracted from E at the first observation, gives E' and we have E' = 104° 7' 55" and the angle at S' = 39° 56' 0" and D' = 1·0772. Similarly, the difference between P and P'' = 2° 18' 29" and this subtracted from 3° 56' 32", the angular motion of the earth during the interval between the first and last observations, gives a correction of 1° 8' 3" by which the the angle E must be reduced to give E'': we have finally, therefore, E'' = 103° 58' 6", and the angle S'' = 39° 22' 15" the resulting value of D'' being 1·0533. The distances of the comet from the earth on the dates computed are, therefore:

	1·0990	1·0772	1·0533
Professor Kobold gives...	1·099	1·0743	1·0532

Such, in brief, is a description of a method of dealing with this problem, which is concise, easily followed in detail and is independent of any special formulae.

AN IRISH PHARMACOPOEIA.

By M. D. HAVILAND.

In most places the time-honoured vocation of herbalist or "wise woman" is extinct, but here and there in out of the way corners of the "Emerald Isle" she still plies a flourishing trade.

Some of the rustic remedies have a certain foundation of truth, but more often they are based upon pure superstition. For instance, in cases of jaundice the Dandelion (*Taraxacum officinale*) is justly regarded as a valuable liver tonic; but on the principle that "like draws to like," the virtue is supposed to reside in its yellow colour, and the Yellowwort (*Blackstonia*) and Saffron are used for the same complaint. In County Kilkenny, a horse with colic is treated with soot, a remedy which might possibly give relief in cases of indigestion and flatulence; but what can be said for "a shrew mouse boiled in milk," which I was solemnly assured was a sure remedy for any weakness of the kidneys?

The whooping or *chin* cough, as it is called in Ireland, carries off a large number of peasant children every year, and consequently many remedies are recommended. A favourite medicine for this complaint is donkey's milk, which, no doubt, does work wonders for ricketty children who have been reared upon stewed tea and Indian meal; but superstition has stepped in and declared that the patient must be passed three times over and under the animal, and then seated upon her back. In County Cork an infusion of the Thang-an-uann or Stitchwort (*Stellaria holostea*), sweetened with sugar candy, is also considered efficacious. Snails boiled in milk are thought excellent for consumptive patients; and the Coltsfoot and Marsh Mallow are justly esteemed as remedies for bronchial affections. In some places the leaves of the Coltsfoot (*Tussilago*) are supposed to "draw" sickness to the house, however.

Along the west coast of Ireland there is a belief that the Common Plantain (*Plantago major*) is good for such ailments as ringworm or parasites in the hair; while another plant of the same family (*Littorella juncea*) is reckoned a sure safeguard against hydrophobia. The properties of the Foxglove (*Digitalis*) are fully recognised by the Celtic herbalists, but Miss Sargent, to whom I am indebted for much interesting information on this subject, tells me that cases of poisoning are not uncommonly traced to its use. A decoction of the stem and leaves in water is a local specific for making the hair grow, and is also rubbed on saddle-galled horses, and on dogs and cats with mange; but if it be applied to any part which the animal can lick, poisoning often results.

In the curing of warts superstition has full play. If you should meet a funeral while suffering from these growths, you should turn and walk three steps with the procession and then bid the warts go to the burial. This is a radical cure. Another plan consists in burying nine blades of Timothy grass; as these decay the warts will disappear. Yet a third remedy practised in County Cork is to anoint the growths with the acrid juice of the *Euphorbia hiberna*, and this is probably the most effectual of the three, as this plant has caustic properties.

Many of these rustic cures owe their efficacy less to the virtues of the "medicine" than to the method of their application. For instance, a remedy for sprains is potato water, but as this is applied as hot as it can be borne, probably the benefit is derived from the hot fomentation; and "crane-oil"—the yellow fat of the heron—is considered good for rheumatism and lumbago, but here again it is most likely the massage in application which gives relief. Yarrow tea is another remedy for rheumatism, and so is a potato carried about in the pocket, but this last is most effectual if begged or stolen. The little bones under the black markings of the haddock—supposed to be the print of St. Peter's fingers—are also carried as charms against toothache. Eel skin is supposed to protect swimmers against cramp—perhaps some properties of the agile fish are thought to linger in its dried epidermis. If anyone has a festered wound caused by a piece of metal, the latter—a nail, a bit of jagged iron, and so on—must be stuck into a raw potato until the sore is healed, otherwise it will mortify. After these, and kindred superstitions, it is interesting to learn that these village physicans are quite aware of the medicinal properties of the Gentian tribe, and recommend the Common Centaury as a tonic for young girls who have outgrown their strength.

No doubt the simple faith with which many of these old cures are used does more to relieve sickness than the medicine itself; but most of them are harmless, if not always very appetizing. Now and then, indeed, one is surprised to find to what extent modern pharmaceutists have been forestalled by these old herbalists of southern Ireland.

THE ERUPTION OF USA-SAN AND THE FORMATION OF A NEW MOUNTAIN IN JAPAN.

By CHARLES DAVISON, Sc.D., F.G.S.

THE eruption of Usu-san in Japan, which took place in the summer and autumn of 1910, was in no way remarkable for its violence or duration. Nor was it attended by any loss of life, for the police wisely took precautions in time and removed all the inhabitants of the disturbed region beyond the reach of danger. But few eruptions have contributed more to our knowledge of the volcanic mechanism; and the formation of a new mountain, not by the accumulation of ashes, nor by the overflow of lava, but by the actual upheaval of the ground, is a phenomenon that is certainly rare in our annals of volcanic action. Fortunately, the different phases of the eruption were witnessed by an observer of wide experience. Professor Omori, the director of the Seismological Institute in the Imperial University of Tokyo, paid two visits to the district, one during the course of the eruption, and the other three months later, and his first report, which has recently been issued, contains so much that is of interest that a summary of it may be useful.

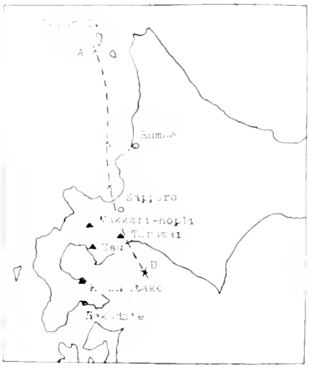


FIGURE 200.
Map of part of the Island of Hokkaido.

The mountain of Usu lies in the south-western portion of Hokkaido, the northern island of the Japanese empire, a little more than fifty miles to the north of Hakodate, and on the north-east coast of Volcano Bay (Figure 200). In the same district there are three other volcanoes, Makkari-nopli, twenty miles north of Usu-san, Tarumai-san, thirty miles to the north-east, and Komaga-take fifty-four miles to the south. Between these volcanoes there is evidently a close connexion. In 1874, there was a great eruption of Tarumai-san, after which, for nearly thirty-two years, no outburst of any importance took place in Hokkaido. In August, 1905, the recent period of volcanic activity began with an eruption of Komaga-take, which lasted a fortnight. This was followed in January, 1909, by a remarkable eruption of Tarumai-san, which lasted more than three months, during which a lava-dome four hundred and forty feet in height was formed, and in July, 1910, by the eruption of Usu-san, here described.

There appears also to be an intimate relation between the volcanic and seismic phenomena of the district. Common as earthquakes are in certain parts of Japan, they are comparatively infrequent visitors in Hokkaido. In April and May, 1908, however, about a year before the eruption of Tarumai-san, the Island of Rebun, close to the northern point of Hokkaido, was disturbed by numerous earthquakes and earth-sounds, the origin of which was under the sea to the south-west of the island (at A, Figure 200). On June 15th, 1910, or about six weeks before the beginning of the Usu-san eruption, a violent local earthquake, also with a submarine origin (at B, Figure 200), caused some damage near Rumoe. This was followed during the eruption, on September 8th, by another earthquake, somewhat less strong, in the same district. Before these two, the last strong earthquake felt at Rumoe occurred thirty-six years earlier, on February 28th, 1874, shortly after the great eruption of Tarumai-san. The origins of the earthquakes of 1908 and 1910, with those of earlier shocks in 1834 and 1856 (at C and D, Figure 200), lie along a band (indicated by the broken line, Figure 200), which runs nearly north and south, passing through or close to Tarumai-san. Taking into account the rarity of earthquakes in Hokkaido, it is difficult to resist Professor Omori's conclusion that the relation between the earthquakes and eruptions of the island is not accidental.

Usu-san is a comparatively small volcano. It rises from an irregularly circular base, about fourteen square miles in area, bounded on the north by the Lake of Toya. It is a flat plateau-like mass with a central crater, the longer and shorter diameters of which are about two thousand three hundred and one thousand eight hundred and sixty yards in length. The north and south rims of the crater are one thousand seven hundred and seventy one feet above the sea, but on the east and west sides there rise two lava domes (O-Usu and Ko-Usu) to heights of two thousand two hundred and seventy and two thousand two hundred and fourteen feet, respectively. The surface of the Toya lake stands at two hundred and seventy-nine feet above sea level. Before the last eruption, the northern slope of the mountain dipped into the lake at a small angle, so that along the southern coast of the lake there was a band of flat ground three miles long and less than half a mile in width. At the east and west ends of this band are two hills, East Maru-yama and Kompira-san eight hundred and fifty-three and seven hundred and eighty-seven feet in height respectively. A little more than half a mile north-east of the latter is a small rounded hill called West Maru-yama, five hundred and ninety feet high.

The last known eruptions of Usu-san took place in the years 1663, 1769, 1822 and 1853. Those of 1663 and 1822 were great eruptions, and, for two or three days before the first outbursts, were preceded by numerous earthquakes and earth-sounds.

The same symptoms heralded the eruption of 1910. In the town of Nishi-Monbets, which lies about five miles to the south of the crater, twenty-five shocks were recorded on July 22nd, one hundred and ten on the following day, three hundred and fifty-one on the 24th, and one hundred and fifty-two up to 10 p.m. on July 25th, when the first explosion occurred. The shocks, as illustrated by the lower curve in Figure 201, reached their greatest frequency twenty-four hours before this eruption. During the immediately preceding twelve hours, only thirty-four were recorded. None of the shocks was of great intensity. Only two of them were strong enough to damage some poorly-built houses, and both disturbed small areas.

The upper curve in Figure 201 represents the variation in barometic pressure at Hakodate, fifty miles south of Usu-san, from July 21st to 29th. It will be noticed that the first premonitory shocks occurred on July 21st when the barometric pressure was a minimum, and that the first volcanic explosion took place on July 25th, when the pressure was a maximum. Roughly, also, the variation in time of earthquake-frequency follows that of the barometric pressure.

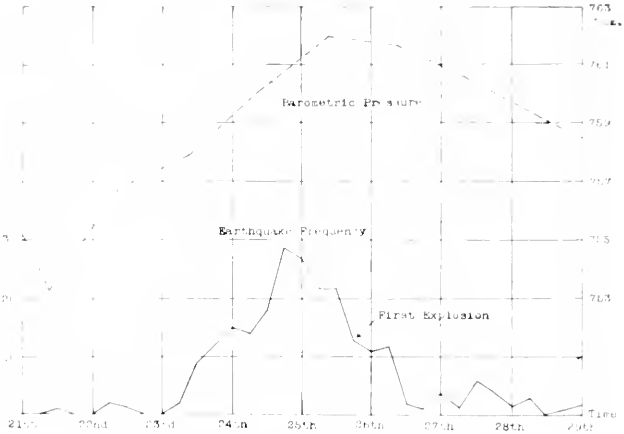


FIGURE 201.
Curves illustrating the number of Earthquake Shocks and the barometric pressure.

The first volcanic outburst was a small explosion at 10 p.m. on July 25th, from the north-west side of Kompira-yama, followed by a second from the west side of the same mountain. These were succeeded by explosions from a number of new craterlets. On August 10th, there were at least twenty-eight craterlets, but explosions from new openings continued to occur until the end of the year. On November 12th, forty-five different craterlets (indicated by the small circles in Figure 202) were counted, the diameters of which varied from one hundred to eight hundred feet. They are situated along three well-defined bands. The most important of these is a curve (A A, Figure 202), rather more than a mile in length, about half a mile from the southern shore of the Toya lake and from six to seven hundred feet above it. It reaches from the western flank of East Maru-yama to the eastern flank of Kompira-yama. Two other bands diverge, one (C) at right angles to the principal band along the axis of West Maru-yama, and the other (B) at a small angle along the axis of Kompira-yama.

FIGURE 202.
Plan of the Craterlets.

It is important to notice that, from the flat ground forming the southern margin of the Toya lake and the scene of the new mountain, these craterlets were entirely absent.

The first two craterlets, as already noticed, were formed at the west end of the zone of disturbance. The third explosion took place at the east end, then followed three more at the west end, and then another at the east end. After this, they occurred along the zone C through West Maru-yama, and in the centre of the principal band, A A. There was thus an alternation of activity from end to end of the area, terminating by confinement to the central region.

All of the craterlets were formed in a thick layer of soft earth, and none of the explosions was of great importance. Most of the craterlets quietly ejected ashes and, except when explosions occurred, were unaccompanied by loud detonations or by earth-tremors. There was no outflow of lava from any one of them. Most were in action for a few days or hours only, and then became completely quiescent. A few, however, remained active for several days, and consequently increased in size until they were more than two hundred yards in diameter. When the eruption was at its height, the scene is said to have been magnificent, as smoke-columns could be seen issuing at once from six or seven different craters. Figure 203 shows eruptions taking place simultaneously from three craterlets, that on the left, known as the Kumantsubo craterlet, being one of the most active craters during the whole course of the eruption.

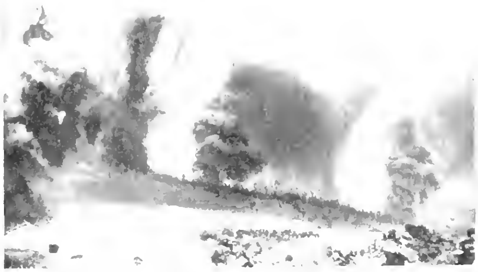


FIGURE 203. Eruptions from three Craterlets.

Some interesting observations on the earthquakes originating from the volcano, especially at the times of the eruptions, were made by Professor Omori. He erected a portable horizontal tromometer and a vertical motion recorder, from July 30th to August 6th, at Nishi-Monbets, five miles from the crater, and from August 6th to 10th, in a school at the foot of East Maru-yama and about three-fifths of a mile from the Kumantsubo craterlet. On the first two days of August, the number of shocks recorded at Nishi-Monbets was about two hundred and ninety, of which ten were sensible to observers in the same town. The number of volcanic earthquakes recorded being about twenty-nine times the number of perceptible shocks, it follows that, if the tromometer had been at work on July 24th, when earthquakes were most frequent, the total number recorded would have been about three thousand eight hundred, or one every twenty-two and a-half seconds. In other words, the ground must have been in a state of almost continual trembling.

A special feature of the records obtained near the Kumantsubo craterlet is the occurrence of well-defined quick unfelt vibrations in addition to the proper volcanic earthquakes. These small vibrations are termed by Professor Omori *micro-tremors*. They were entirely absent at Nishi-Monbets, and rapidly die out with increasing distance from the origin. As a rule, moderate explosions in the Kumantsubo craterlet were not accompanied by marked micro-tremors, but violent explosions from this and other craterlets in the vicinity were accompanied, and often preceded for a few minutes, by well-pronounced micro-tremors. They also occurred when the smoke ejections from the different craterlets were very insignificant or even had completely ceased. It would seem that, if explosions were prevented by some temporary obstruction in a craterlet, the pent-up steam and gases produced in consequence a series of minor earthquakes resulting in the micro-tremors.

FIGURE 204. The new Mountains seen on the right hand side of the column of smoke.

On August 6th, Professor Omori discovered accidentally that the eastern part of the south coast of the Toya lake (from D to E, Figure 202) had risen about a yard, causing the lake-margin to retreat about seven yards. At the foot of East Maru-yama, the movement continued, but at a decreasing rate, until, at the end of August, the total rise of the coast was about four feet, and the recession of the coast line about twenty-three yards.

The elevation was not, however, confined to the shore of the lake. It was still more marked on the northern flank of the volcano, where an area about three thousand yards long, and six hundred and twenty-five yards wide was gradually raised until it became a new mountain. The area, which is represented by dotted shading in Figure 202, is bounded on its southern side by two lines of dislocation (I and II, Figure 202), which are parallel to, and just to the north of, the principal explosive zone, AA. Professor Omori thinks it probable that the elevation of the new mountain began on or about July 21st, when the first earthquakes occurred; but it was only after August 20th that its appearance began to attract general attention. Early in September, the elevation must have been far advanced; for, on the 7th of that month, some houses, built on land which previously sloped at an angle of five degrees, were overthrown in consequence of the increasing inclination. Two months later, the height of the ridge of the new mountain was found by barometric measurements to be six hundred and ninety feet above the level of the lake. As its height before the eruption began was only one hundred and eighty feet above the same level, it follows that the total elevation from the end of July to the beginning of November was five hundred and ten feet, giving an average rate of upheaval of a little over five feet a day. Some time before or after this, the process of elevation must have ceased and an opposite movement set in, for, during April, 1911, the height of the ridge was found to be one hundred and twenty feet less than in the previous November.

The new mountain is shown to the right of the column of smoke in Figure 204, the dome on the left of the figure being O-Usu. The southern face of the new mountain consists of the steep surface of the dislocations (I and II), the height of the slope being about three hundred feet, its inclination varying from thirty to sixty degrees. The other side now slopes directly down towards the lake at an angle of about thirty degrees. It is probable that the slope is continued beneath the lake. If so, this would account for the rise, by more than a foot, which took place in the level of the water surface of the lake in the latter part of July, the rainfall at this time having been insignificant.

Professor Omori regards the formation of the new mountain as the primary or fundamental disturbance, and the earthquakes and volcanic outbursts as secondary or attendant phenomena. The volcanic energy of Usu-san, in his opinion, was manifested by pushing upwards the underground lava-masses beneath the three zones of eruption (A, B, C, Figure 202), the result being the elevation of the new mountain. In consequence of this action, fractures must have been formed below the surface, and the production of such fractures must have caused the premonitory earthquakes, the greatest frequency and intensity of these shocks coinciding with the epoch when the formation of the fractures was at an end. Then followed the explosive stage in the volcanic action, when, on the night of July 25th, the gases and vapours began to escape from the zones so prepared. The elevation of the new mountain was most marked after the epoch of maximum explosive activity, as the continued uplifting of the ground would meet with few obstacles once the actual dislocation had been effected.

AN AEROPLANE INTENDED TO BE NON-CAPSIZABLE.

By FRANK C. PERKINS.

THE design and construction of what is claimed by William P. Bary, of Paterson, New Jersey, to be a non-capsizable aeroplane, is seen in Figure 205. It is held that the object in developing this aeroplane was to maintain lateral balance and, at the same time, furnish a means whereby it would be impossible for the machine ever to acquire an angle in descent from which it would be impossible for the operator to recover with the use of the controls.

FIGURE 205.

It is held that this has been attempted with a full understanding of the causes of a machine getting beyond the control of the aviator, also the effect of a low centre of gravity in causing oscillation and the dangers attendant. The inventor states that after proving the non-capsizable features in gliding flights and the efficiency in towed flights, a motor was installed which, it is said, has proven only just powerful enough to get the machine off the ground under the most favourable conditions.

KLEPTOMANIA.

By R. M. W.

There is nothing the average Englishman prides himself so greatly upon as his common sense. If you ask him he will tell you that he detests humbug in any shape or form, and believes in the grand old custom of calling a spade a spade. Thus, in his terse parlance a man, who shrinks from danger is always a coward, a man whose shifty eyes seem incapable of looking one in the face a "twister," and the individual with a passion for handling other people's property a thief. Such terms as neuropath, kleptomaniac, and the like, are apt to be regarded by him as rather contemptible excuses invented by medical men to cover the sins of their well-to-do patients. Who, for example, has not heard the biting comment "Poor men's sins, rich men's maladies"?

Yet, and this in spite of the fact that such strictures are sometimes justified, there do exist certain true mental diseases, the symptoms of which are easily capable of misconstruction as criminal. And foremost among such is kleptomania, an affliction which compels its unhappy victims to the most persistent, incorrigible and irrational thieving. For the true kleptomaniac can no more refrain from stealing than can the unfortunate possessed by a mania for homicide from murder.

It is the pleasure and excitement of the act of stealing, never, or almost never, the desire of the object stolen, which tempts the kleptomaniac and which distinguishes her (kleptomaniacs are usually women) from the common thief. The following case, which occurred in the writer's practice, illustrates this in a most striking manner.

The individual concerned was a servant girl in a large country house. She came to her employer with a somewhat vaguely-worded character. She was a strong-looking, well-built girl, distinctly handsome and most pleasant and obliging. Her mistress was highly pleased with her, so much so indeed that, on leaving home to go abroad for a few weeks, she entrusted her with the care of the house and with the keys of the store-cupboard and wine-cellar.

Some time after her return she had occasion to visit the latter place. To her amazement she found that several bottles of champagne and at least half a dozen of port were missing. In view of the confidence reposed in the girl this came as a very unpleasant surprise.

Being, however, a singularly fair-minded woman, she decided, even in the face of such strong evidence of guilt, to take no immediate steps to bring the theft home; but instead, and in a way to arouse as little suspicion as possible, made enquiries of certain of the other servants as to the girl's behaviour during her absence. Again, to her surprise, she learned that this had been correct in every particular. There was not even a suggestion of intemperance.

Greatly puzzled, she had almost made up her mind that she must have been mistaken, when one evening she herself encountered the suspect in the act of carrying a bottle of champagne out of the cellar. Taxed with her guilt, the servant broke down completely and confessed everything. She had begun to tipple in her last place, and finding the opportunity to her hand had yielded to what was an overwhelming temptation. She pleaded earnestly for another chance.

After some hesitation this was granted, in the shape of a month's probation under strict surveillance. But long before that time had elapsed, matters were again brought to crisis-point by the reported disappearance of a bottle of methylated spirits. At this juncture the writer was called in, and the facts of the case placed before him.

He had to own himself completely baffled by them. For here was a record of what appeared like steady drinking (champagne, port—at last, when the supply of wine failed, actually methylated spirits) occurring under the sharp eyes of half a dozen fellow servants, not one of whom had so much as suspected anything amiss. On the face of it the thing seemed incredible. Sooner or later such a state of affairs must have aroused comment and suspicion. At the mistress' request he saw the servant alone and questioned her carefully. She admitted everything. She actually seemed anxious to do so. She had taken the wine to her bedroom and drunk it there during the night. By morning all effect had passed off. She assured him that the empty bottles were hidden at the bottom of her trunk.

There seemed to be nothing for it but to recommend immediate dismissal. At the last moment, however, and by the merest chance, another explanation suggested itself *kleptomania*. Proof of the assertions was demanded in the shape of the empty bottles. Instantly all contrition and humility disappeared. The limp, tearful servant became a hard-eyed defiant woman, daring anybody to interfere with her personal belongings. Faced, however, with the alternative of the police, she at length capitulated.

Then the astounding truth was revealed. In the box were no fewer than eleven bottles, the contents of which were, in each case, absolutely intact. Along with them were a man's waistcoat, recognised as having been stolen from a recent visitor, a razor-strop, a faded blue table-centre, an old linen petticoat, the property of the mistress of the house, and several equally absurd and valueless articles, Now, it must be obvious that this collection was not made with a view to subsequent sale, seeing that valuable jewels and silver plate could have been obtained with just as little, indeed with considerably less, trouble. What then prompted these entirely meaningless thefts? The only possible answer is mania, an insane desire to steal for mere stealing's sake, or in other words, the morbid craving for excitement which is at the bottom of so many motiveless and useless crimes, and which, again and again, has driven apparently sensible men and women to ruin and even suicide. Such diseases as kleptomania belong exclusively to civilisation. They are the product of an age of sensationalism, wherein all things, books, plays, even sermons, are valued according to their capacity to thrill. And, naturally enough, woman, with her delicately-balanced nervous organisation, is the first and chiefest sufferer.

THE NEW ASTRONOMY.

NOVA GEMINORUM.

By PROFESSOR A. W. BICKERTON.

The new star in Gemini seems to be behaving exactly as the other recent novae from which spectrograms have been obtained. Professor Fowler says that the little spectrum he has obtained by his student's small telescope is as near as possible a replica of Nova Aurigae. By the kind permission of the Astronomer-Royal I was allowed to inspect their spectrograms. The first Greenwich spectrogram shows the blaze bands of hydrogen, each one being bordered on the more refrangible edge by a dark absorption band. The velocity shown by these dark bands seems to me to be less than half of Nova Persei and perhaps slightly greater than Nova Aurigae, something like four hundred miles a second. This was taken on the 15th. A break in the clouds on the 18th enabled the star to be again cleverly captured just long enough to get a very narrow spectrum. The star is rapidly losing light and the shadow bands are much thinner, almost gone, without apparent lessening of displacement.

Surely this evidence must convince astronomers that novae are the explosive third bodies struck from grazing suns. There is not a single minute character of the complex progressive details of their light curves, not one characteristic of all the multiple series of spectrograms of novae, but are observations confirming physical deductions from the third body and published a generation ago in the original papers in the transactions of the New Zealand Institute.

Let us take the light curve. The sudden rise is the explosion of the impact, taking about an hour. The further rise is the expansion due to thermodynamic instability. The descent of the curve is due to the rareness of the gas and the consequent infrequency of molecular encounters that must be associated with excessive expansion. Then comes the oscillation of light; this is due to the periodicity of the pulsation of the pressure of the gaseous nucleus under the influence of the struggle of attraction and inertia. Then, again, notice the extraordinary evidence of the series of spectrograms. The spectrum that shows immediately after impact is continuous, because the light gases are at the centre and have not escaped. Presently they escape and produce black lines. These light gases by taking heat from the heavier acquire enormous velocity. One thousand miles a second was observed in Nova Persei. Hence they soon become vast ensphering shells ever expanding. As the motion is in all directions the line becomes a blaze band. The nucleus although much expanded produces a continuous spectrum, except those isochromatic rays passing to us through the hydrogen gas shell. These suffer reversion and a black line results. This portion of the shell has the greatest resultant speed in our direction, hence is on the extreme edge towards the violet. So we have physical deductions exactly borne out by observations. But the speed of the escaping gas is so enormously above the critical velocity that it will continue steadily to expand. Hence it happens that the portion of the shell in front of the nucleus becomes so rare that absorption ceases and the black lines die out without change of position. Here again deduction and observation agree, as do every subsequent item in the series of spectrograms. Nova Persei was so bright and so well observed that every detail of the character of the bands due to axial extrusion, every difference of the elements and their deduced behaviour, were all confirmed, until the theory of the third body is no longer a mere hypothesis but an absolutely demonstrated deduction. In "The Earth's Beginnings" Sir Robert Ball sums up many observations and concludes absolutely in favour of the idea that novae are undoubtedly the result of grazing impact. The evidence that has accumulated since he wrote is enormously greater than that of which he made use.

FISHERIES AND SHIPPING MUSEUM FOR HULL.

At Hull, on Saturday afternoon, March 30th, a museum was opened to the public which is probably the only one of its kind in the country. It is devoted entirely to objects connected with the fishing and shipping industries, which play so prominent a part in the city. The museum, which is a large building, and top lighted, is the gift of Mr. C. Pickering, J.P., a prominent Hull merchant. The exhibits, which have been arranged by the curator, Mr. T. Sheppard, F.G.S., include an exceptionally fine series of harpoons, harpoon guns, flensers, blubber spades, and other objects connected with the old whaling trade, which commenced at Hull in the sixteenth century, and which may be said to have started the present flourishing oil and fishing industries. On the walls are many valuable paintings of the old Hull whalers in the Arctic, shewing the methods of fishing, as well as paintings and drawings of other Hull ships, from the earliest times to the most recent. There are also dozens of models of ships, illustrating the evolution and growth of the vessels from the old "wooden walls" to modern battleships and liners, all built at Hull. The various phases in the evolution of the old fishing smack into the modern steam trawler are also well shewn by models. There is a valuable set of Esquimaux boats and fishing appliances, brought to Hull during the early part of last century by the old whalers. Amongst more modern fishing appliances are some remarkable models, which were shewn at the Japan-British Exhibition, and were presented to the Hull Corporation by the Japanese Government. These are supplemented by models of Hull fishing nets, and so on, ancient and modern. There are preparations shewing the growth of the prawn, trout, eel, carp, oyster, and so on, and others illustrating the nervous system, blood vessels, skeletons, and so on, of fishes. There is a representative set of skeletons of whales and fishes, large and small, and a large number of mediaeval and later earthenware vessels, and so on, which have been dredged up from the Dogger Bank by the Hull trawlers. As the museum is situated at the entrance to the new park, near the centre of the fishing industry, it bids fair to become popular. This is the third public museum which has been opened at Hull during recent years, while the largest has been increased to twice its size.

THE FACE OF THE SKY FOR JUNE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun R.A.	Sun Dec.	Mercury R.A.	Mercury Dec.	Venus R.A.	Venus Dec.	Mars R.A.	Mars Dec.	[illegible] R.A.	[illegible] Dec.	[illegible] R.A.	[illegible] Dec.	[illegible] R.A.	[illegible] Dec.
Greenwich Noon. June 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 15.

Date.	Sun P	Sun B	Sun L	M[illegible] P	Mars P	Mars B	Mars L	Mars T	Mars Q	Jupiter [illegible]	Jupiter [illegible]	Jupiter [illegible]	Jupiter [illegible]	Jupiter [illegible]	Jupiter [illegible]
Greenwich Noon. June 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 16.

m, *e* denote morning, evening respectively. Greenwich Civil Time (day commencing at midnight) is used. P is the position angle of the body's North Pole measured eastward from the North Point of the disc. B, L are the Helio-(planeto-)graphical latitude and longitude of the centre of the disc (N. latitudes +). In the case of Jupiter there are two systems of longitude, the first for the equatorial region, the second for the temperate zones.

T denotes the time of passage of the zero meridian. Intermediate passages for Mars, Jupiter I and II may be found by applying multiples of $24^h\ 39{\cdot}7^m$, $9^h\ 50{\cdot}4^m$, $9^h\ 55{\cdot}6^m$ respectively.

Q, q for Mars are the position angle and amount of the greatest defect of illumination.

THE SUN reaches his greatest North Declination (Summer Solstice) at $7^h\ 17^m$ *e* on June 21st. During June the semi-diameter diminishes from 15′ 47″·6 to 15′ 45″·4 (practically the minimum). Sunrise $3^h\ 51^m$ on 1st, $3^h\ 49^m$ on 30th; sunset $8^h\ 4^m$ on 1st, $8^h\ 18^m$ on 30th. The chief interest now is in looking for spots in high solar latitudes, heralds of the new cycle.

MERCURY is in superior conjunction with the Sun on June 17th noon. At the beginning of the month he is a morning star, disc $\frac{7}{8}$ illuminated; at the end an evening star, $\frac{9}{10}$ illuminated. The semi-diameter remains nearly steady at $2\frac{1}{2}$″. Mercury is $\frac{1}{2}$° N. of Saturn June $3^d\ 4^h$*m*, and $\frac{1}{2}$° N. of Venus June $12^d\ 5^h$*m*.

VENUS is a morning star, approaching superior conjunction. It is almost fully illuminated, semi-diameter about 5″.

THE MOON is at L. Quar. June $8^d\ 2^h\ 36^m$*m*, New $15^d\ 6^h\ 24^m$*m*, F. Quar. $21^d\ 8^h\ 39^m$*e*, Full $29^d\ 1^h\ 34^m$*e*. Apogee $4^d\ 1^h$ *e* (semi-diam. 14′ 46″); Perigee $16^d\ 4^h$ *e* (semi-diam. 16′ 30″); Maximum Librations 6° N. June 3^d, 7° E. 11^d, 7° S. 16^d, 7° W. 23^d, 7° N. 30^d. The letters indicate the region of the Moon's limb that is brought into view by libration; E, W. mean the East and West with regard to our sky, not as they would appear to an observer on the Moon. Thus W. is the side towards Mare Crisium.

MARS is getting too far away for profitable work; the physical ephemeris in *The Nautical Almanac* only continues up to the middle of the month. Semi-diameter 2″.

JUPITER is in opposition on June 1st, and is therefore at his best position for the present year; but his south declination is unfavourable for good definition in England. Equatorial

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h m		h m	
June 2	Lacaille 7730	7·0			3 39 *m*	210
„ 3	B.A.C. 6628	5·0	3 [illegible] *m*	55	4 11 *m*	267
„ 6	B.A.C. 70[illegible]8	6·1	1 [illegible] *m*	67	2 7 *m*	235
„ 13	65 Arietis ...	6·0	2 41 [illegible]	5	3 5 *m*	300
„ 20	σ Leonis	4·2	10 45	115	11 30 [illegible]	303
„ 22	BD −6° 3705 ...	7·0	11 [illegible]	127		
„ 29	B.A.C. 6160	6·4	1 50 *m*	40		

From New to Full disappearances occur at the Dark Limb, from Full to New re-appearances.

TABLE 17. Occultations of stars by the Moon visible at Greenwich.

[illegible] diameter [illegible] The configuration of the satellites [illegible]

Day.	West.		East.	Day.	West.		East.
[illegible]	3[illegible]			16	4312		
[illegible]	3[illegible]			17	43		1[illegible]
[illegible]	3[illegible]		[illegible]	18	4		3
4	32			19	42	⊙	3
[illegible]				20	4		123
[illegible]			[illegible]	21	41	⊙	2
[illegible]	[illegible]		[illegible]	22	324		1
8	32		14	23	312		4
[illegible]	[illegible]	2●	[illegible]	24	3		124
[illegible]	3		124	25	1	⊙	34
[illegible]	2	1●	34	26	2	⊙	34
[illegible]	[illegible]		34	27			1234
13			12[illegible]	28	1		324
14	13		2	29	32		14
15	3[illegible]		1	30	31		4

Satellite phenomena visible at Greenwich. $1^d\ 1^h\ 7^m$ *m* II. Sh. I., $1^h\ 9^m$ *m* II. Tr. I., $3^h\ 47^m$ *m* II. Sh. E., $3^h\ 47^m$ *m* II. Tr. E.; $2^d\ 10^h\ 1^m\ 18^s$ II. Ec. R.; $3^d\ 1^h\ 53^m$ *m* I. Oc. D.; $3^d\ 11^h\ 1^m$ *e* I. Tr. I., $11^h\ 4^m$ *e* I. Sh. I.; $4^d\ 1^h\ 14^m$ *m* I. Tr. E., $1^h\ 18^m$ *m* I. Sh. E., $2^h\ 32^m$ *m* III. Oc. D.; $4^d\ 8^h\ 19^m$ *e* I. Oc. D., $10^h\ 34^m\ 32^s$ *e* I. Ec. R.; $8^d\ 3^h\ 23^m$ *m* II. Tr. I.; $9^d\ 9^h\ 36^m$ *e* II. Oc. D.; $10^d\ 0^h\ 37^m\ 52^s$ *m* II. Ec. R.; $11^d\ 0^h\ 45^m$ *m* I. Tr. I., $0^h\ 59^m$ *m* I. Sh. I., $2^h\ 58^m$ *m* I. Tr. E., $3^h\ 12^m$ *m* I. Sh. E.; $11^d\ 10^h\ 3^m$ *e* I. Oc. R.; $12^d\ 0^h\ 28^m\ 38^s$ *m* I. Ec. R.; $12^d\ 9^h\ 24^m$ *e* I. Tr. E., $9^h\ 41^m$ *e* I. Sh. E.; $14^d\ 8^h\ 27^m$ *e* III. Sh. I., $9^h\ 13^m$ *e* III. Tr. E., $10^h\ 38^m$ *e* III. Sh. E.; $16^d\ 11^h\ 52^m$ *e* II. Oc. D.; $18^d\ 2^h\ 30^m$ *m* I. Tr. I., $2^h\ 53^m$ *m* I. Sh. I.; $18^d\ 9^h\ 23^m$ *e* II. Tr. E., $10^h\ 14^m$ *e* II. Sh. E., $11^h\ 47^m$ *e* I. Oc. D.; $19^d\ 2^h\ 22^m\ 50^s$ *m* I. Ec. R.; $19^d\ 8^h\ 56^m$ *e* I. Tr. I., $9^h\ 22^m$ *e* I. Sh. I., $11^h\ 9^m$ *e* I. Tr. E., $11^h\ 36^m$ *e* I. Sh. E.; $20^d\ 8^h\ 51^m\ 23^s$ *e* I. Ec. R.; $21^d\ 10^h\ 34^m$ *e* III. Tr. I.; $22^d\ 0^h\ 25^m$ *m* III. Sh. I., $0^h\ 33^m$ *m* III. Tr. E.; $24^d\ 2^h\ 9^m$ *m* II. Oc. D.; $25^d\ 9^h\ 1^m$ *e* II. Tr. I., $10^h\ 8^m$ *e* II. Sh. I., $11^h\ 39^m$ *e* II. Tr. E.; $26^d\ 0^h\ 48^m$ *m* II. Sh. E., $1^h\ 32^m$ *m* I. Oc. D.; $26^d\ 10^h\ 41^m$ *e* I. Tr. I., $11^h\ 17^m$ *e* I. Sh. I.; $27^d\ 0^h\ 54^m$ *m* I. Tr. E., $1^h\ 31^m$ *m* I. Sh. E.; $27^d\ 10^h\ 45^m\ 42^s$ *e* I. Ec. R.; $29^d\ 1^h\ 55^m$ *m* III. Tr. I.

When phenomena are separated by a comma they are all on the same day.

Eclipse Re-appearances occur high right of the inverted image, taking the direction of the belts as horizontal.

SATURN and NEPTUNE are too near the Sun for convenient observation.

U[illegible] is coming into a better position, semi-diameter 2". It is [illegible] south of ρ Capricorni.

METEOR SHOWERS (from Mr. Denning's List):

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
May 30 to Aug.	333	28	Swift, streaks.
May — June	280	32	Swift.
" July	252	21	Slow, trains.
June to Aug.	310	61	Swift, streaks.
" Sept	335	57	Swift.
" July	245	64	Swift.
" —Aug.	303	24	Swift.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
H I. 128	$15^h\ 1^m$	N 2·[illegible]	Nebula.
H I. 215	15 5	N 56·1	Nebula.
M. 5	15 13	N 2·5	Cluster; near 5 Serpentis.
M. 80	16 11	S 22·8	Rich cluster, midway between α, β Scorpii
M. 4	16 17	S 26·3	Large faint cluster.
H VI 40	16 27	S 12·8	Large faint cluster.
M. 13	16 38	N 36·6	The great cluster in Hercules, one third of way from η to ζ, just visible to naked eye.
Σ 5 N.	16 40	N 24·0	Planetary nebula, 8" diameter.
M. 12	16 42	S 1·8	Faint cluster.
H IV 50	16 40	N 47·7	Faint planetary nebula.
M. 10	16 52	S 4·0	Bright cluster.
M 62	16 55	S 32·0	Cluster.
M. 19	16 56	S 26·1	Large cluster.

DOUBLE STARS. The limits of R.A. are 15^h to 17^h.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
44 Boötis ...	15 1	N 48·0	5, 6	242°	4	White, grey.
Σ 1919	15 9	N 19·5	6, 7	9	24	Yellow, white.
Σ 1926	15 12	N 38·5	6, 8	258	1	Yellow, blue.
Σ 1931	15 14	N 10·7	6, 7	171	13	White, blue.
Σ 1932 ...	15 15	N 27·1	5, 6	333	½	White.
η Coronae Bor. ...	15 20	N 30·6	5, 6	45	1	White.
[illegible] Boötis	15 21	N 37·6	6, 7	60	1	Greenish white.
δ Serpentis	15 31	N 10·8	3, 4	184	4	Greenish white, purple.
ζ Coronae	15 36	N 36·9	5, 6	304	6	Greenish white.
γ Coronae	15 39	N 26·5	4, 7	112	[illegible]	Yellow, blue
ξ Scorpii ...	15 59	S 11·2	5, 7	64	7	Yellowish white.
			The brighter star is a close double.			
49 Serpentis	16 0	N 13·7	6, 7	336	4	White.
σ Coronae ...	16 11	N 34·0	5, 6	220	5	Yellowish, bluish.
λ Ophiuchi	16 26	N 2·1	4, 6	65	1	Yellow, blue.
17 Draconis	16 34	N 53·1	5, 6	107	3	White.
ζ Herculis	16 38	N 31·8	3, 6	130	1	Yellow, green.
20 Draconis	16 56	N 65·1	6, 7	80	[illegible]	White.

TABLE 18.

FERMENTS AND FERMENTATION.

By DAVID FRASER HARRIS, M.D., B.Sc. (Lond.), D.Sc. (Birmingham).

Lecturer on Physiology, the University, Birmingham.

MANY people would hardly be prepared for the statement that the clotting of milk, the decomposition of a dead body and the digesting of one's dinner are all regarded by physiological chemists as three different examples of the same process, namely fermentation. Yet such is the case: a ferment clots milk, a ferment disintegrates dead matter, and ferments render our food-stuffs capable of absorption. In a vast number of instances where it would have been previously said that such and such an action was "vital," we now say that it is due to a ferment: the action is none the less vital, however, because we have discovered the messenger sent out by the living substance to do its bidding.

Now, while it seems reasonable to speak of the digestion of our food as a vital process, because it goes on inside our living bodies, there seems nothing particularly vital about the clotting of milk to make cheese, or, still less, anything vital about the decomposition of a dead body; yet each of the specific agents whose activity brings about the digestion, the clotting and the disintegration are solely the products of life alone. A ferment is something produced, as far as we at present know, only by living matter for the purpose of effecting certain definite changes in certain substances with which it is to come in contact. The substances thus undergoing change need not necessarily remain within the organ which produced the ferment. For instance, the ferment pepsine of the gastric juice can digest a piece of meat, or fish, or an egg, in a glass vessel kept at the temperature of the blood. This was the discovery of Reaumur (1752), and of Spallanzani (1777), both of whom obtained gastric juice from birds, and showed that the juice was capable of carrying on digestion outside the body, and that the meat was *not* putrified in the process. A young medical man, Stevens, of Edinburgh, also in 1777, published experiments on gastric juice and its activity outside the body. Up to the time of Reaumur, digestion and putrefaction were believed to be processes of exactly the same order chemically. The digestion of meat in a glass vessel is as "vital" as its digestion in the stomach, because as yet no chemist has manufactured pepsine, an organic substance which under certain physical conditions carries out the precise chemical changes which we call digestive. No organic chemist has as yet made pepsine in the sense that he has made sugar, or urea, or indigo—all of which were at one time believed to be able to be made only through the instrumentality of life itself. Pepsine was so named in 1836 by Theodor Schwann.

Now what is it that the ferment has done to the meat whether in the body or in the glass vessel? It has, in the first place, altered its physical state, for the insoluble meat is now a solution filterable and translucent, and, secondly, it has transformed it chemically, for it now consists of highly soluble substances known as peptones: the flesh, or fish, or egg has been "peptonised," made capable of absorption into the blood.

But the ferment has done nothing to the meat which the chemist could not have done without pepsine, had he been given sufficient time. By boiling the meat for long enough under high pressure, and therefore at a high temperature, he could in the end have peptonised, or hydrolysed, the egg-albumen which was what the ferment did in half-an-hour at blood heat, and under ordinary atmospheric pressure.

In a particular case it has been calculated that a ferment effects as much in six hours at 40° C. as water at that temperature, without a ferment, would effect in three *years*.

A ferment, then, is a vital agent, although not a vital substance, which accelerates the velocity or rate of change of some physico-chemical process. Pepsine is something manufactured and secreted by the cells of the gastric glands, and no other cells can vicariously manufacture it. We may take it as a type of ferment: it is one of the longest known animal ferments and it can be obtained in a state of comparative purity. To obtain it, the very best method is to chill an animal's pure gastric juice to 0° C., when a fine powdery precipitate falls, closely associated with the hydrochloric acid of the juice.* This powder may be purified, and on being carefully dried will retain its digestive power indefinitely. The full history of the discovery of the various ferments and their characteristics is virtually the history of the establishing of the doctrine of Biogenesis, which is, that life always arises from a pre-existent living being and never from non-living material.

Into this subject we must not at present digress; but to understand the present views of fermentation we should transport ourselves back to the time when fermentation was regarded by the acutest thinkers as a purely chemical or non-vital affair. The controversy was about the cause of "fermentation" *par excellence*, that is alcoholic fermentation, the changing

* This only free acid in the human body was discovered to be a constituent of gastric juice by the English doctor Prout in 1824.

of sugary liquids into alcohol and carbon dioxide. We speak yet of beer and ale as being "fermented" beverages. In the early years of the nineteenth century the cause of this fermentation was beginning to be attributed to the presence of the yeast-plant or Torula (*Saccharomyces Cerevisiae*). This small fungus had indeed been described by the indefatigable Leeuwenhoek, as early as 1675, in the deposit below a fermenting liquid; no use of this fact was made, however, until about one hundred and sixty years later, when Schwann and Caignard de la Tour, in 1838, demonstrated that these minute bodies were "cells" of vegetable origin and grew abundantly in solutions of sugars. It was natural to connect the presence of these minute fungi with the occurrence of fermentation, but the biologists had to contend against the prestige of the great Swedish chemist Berzelius who held that fermentation was essentially a chemical affair due to "catalysis."

Liebig, in 1848, admitted that the yeast-plant might be a link in the chain of causal antecedents in the fermentation. The essence of his view consisted in this, that fermentation was a disturbance in the molecular structure of the sugar, of such a kind that under the influence of a catalyst the complex molecule fell apart into the simpler ones of succinic acid, alcohol and carbon dioxide. He compared it to the "catalytic" action of metallic platinum black, which causes hydrogen peroxide to be reduced to water and "nascent" hydrogen, in other words, to be chemically broken down. The platinum was a catalyst, it was not changed in the process.

For a time the orthodox view was that of the chemists: fermentation was "catalytic," a view which in 1850 explained nothing; but Berzelius and Liebig had said it was catalytic, and therefore it must be so!

But the biologists on continuing to study the subject found that the more active the fermentation, the more rapidly the plants grew, that the higher the temperature, up to a certain point, the more active was the fermentation, but that boiling the liquid put an end to the whole process. Freezing the liquid arrested without destroying the ferment. All this looked very like life, albeit the living things were invisible to the unaided eye. The conclusion seemed irresistible that as the fermentation was due to the yeast-plant, the plant itself might be regarded as a ferment, a living ferment, an organised or insoluble ferment, to distinguish it from a ferment like pepsine, which seemed to belong to another class non-living, unorganised, soluble. For many years these two species of ferments were recognised. About 1879 the physiological chemist, Kühne of Heidelberg, suggested the name Enzymes or Zymins for the soluble ferments, the secretions of living cells.

The classical experiment of Helmholtz, in 1843, seemed to demonstrate very simply that alcoholic fermentation was due to an insoluble ferment. He placed some boiled grape-juice in a bladder, which he immersed in a vat of fermenting grape-juice; after a certain time the contents of the bladder were found *not* to have fermented, therefore the ferment was not so soluble as to pass through the bladder used. Later it was shewn that the ferment could be excluded by cotton-wool.

Helmholtz, others, and finally Tyndall in this country, made it certain that fermentation was not due to the presence of air or of oxygen, as some of the chemists had thought possible. Fermentation and putrefaction were alike vital, for, as time went on, it appeared that what applied to the former seemed equally to apply to the latter.

Dead matter, it seemed, would not change its physico-chemical state unless ferments now identified as microscopic saprophytes could gain access to it. Putrescible matter boiled did not putresce but remained indefinitely in the *status quo ante* until micro-organisms were permitted access to it, when it promptly decomposed. These micro-organisms were organised ferments, some of which needed oxygen (aërobic), some of which did not need oxygen (anaërobic) and some of which could live with or without oxygen (facultative); this classification was due to Pasteur (1857–61).

Dead matter putrefied because it was invaded by organised ferments which broke it down into chemical substances (amides and amino-acids), simpler than the proteins (albumins) of which it was composed at the moment of death. Thus post-mortem putrefaction was directly due to the presence of life; if the air going to putrescible material was previously passed through a red hot tube, so that all micro-organisms were burnt out of it, the material did not putrefy.

Before long, bacteria, rod-like forms, were found to be the *vera causa* of putrefaction; bacteria of other shapes were found to be the cause of many infectious diseases thenceforth called "zymotic," that is, fermentative. Disposal of the dead — vegetable or animal — is therefore the duty of the humblest species of plant life, the organised ferments.

For many years the sharp distinction between the organised and unorganised ferments was maintained by biologists; but in course of time it became apparent that the organised, or insoluble, ferments could, in reality, carry out the chemical changes peculiar to them only by means of something secreted by them through their cellulose cell-walls. Obviously if no interchange of material went on between the protoplasm inside the cell-wall and the sugar outside, then the living plant cell could not influence or alter the state of the sugar in any way whatever, for in histology we do not believe in "action at a distance." If the cell-membrane was absolutely impermeable, then the yeast was exactly as an inert body might be in the sugar.

(To be continued.)

OF THE KNOWLEDGE OF HISTORICAL MEDALS.

By A. M. BROADLEY.

Author of "Dr. Johnson and Mrs. Thrale."

A MEDAL has been described as "a circular piece of metal issued to record or commemorate an event or a person, and embellished with devices and inscriptions representative, symbolical or connected with its particular purpose." This rather vague definition can scarcely be regarded as satisfactory, the shape of a medal not necessarily being circular; for many well-known examples are oval, while a few are octagonal. The most familiar form of medal is that struck by the State as a reward for military or naval service, and worn as a distinctive decoration by the recipient. Our present concern, however, is principally not with medals designed and issued to serve as badges, but with those intended only for commemorative purposes. It is to historical medals that Joseph Addison alludes in his "Dialogue" when he speaks of "Critics in rust." Possibly the fondness of Englishmen for medals is not as great as that of the foreigner, for a modern writer declares that "while we distribute tracts the French distribute medals." From the end of the fourteenth century downwards some of the world's greatest artists have turned their attention to the designing of medals. Amongst the great mediaeval medallists may be mentioned the names of men like Vittore Pisano, Matteo de Pasti, Benvenuto Cellini and Albert Dürer. In the sixteenth and seventeenth century their traditions were perpetuated in France by Primavera, Pilon and Dupré. The English commemorative medal begins with the reign of Elizabeth, although we have portrait medallions of Henry VIII, Edward VI and Queen Mary. The fine English medals of the Commonwealth and the reign of Charles II. were the handiwork of those great engravers, Thomas and Abraham Simon. Rawlins was also employed by Charles II after the Restoration. From the time of William and Mary onwards nearly all the designers of British medals were foreigners. The collecting of war medals is a cult of itself, but for some unaccountable reason the public interest in historical medals has languished, although its votaries were once as numerous and enthusiastic as those of philately are to-day, when the expenditure of the £2,500 necessary to purchase specimens of the penny red and twopenny blue Post Office Mauritius, intrinsically worth the fraction of a farthing, would suffice to secure a fine cabinet of gold and silver medals illustrating English history from the reign of James I down to the coronation of George V, including possibly half a dozen unique examples!

There are few more useful aids to history than the monumental work, in two volumes, compiled by the late Edward Hawkins, and entitled "Medallic Illustrations of the History of Great Britain and Ireland to the death of George II." This book was edited by A. W.

FIGURE 206. The Naval Medal of 1653 for the Battle of Portland, in the collection of Messrs. Spink.

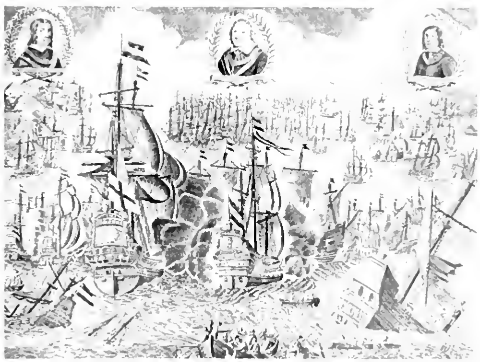


FIGURE 207. A rare Dutch Engraving of the Battle of Portland, February, 1653, in the collection of A. M. Broadley.

FIGURE 208. A Restoration Medal of 1660.

Franks and H. A. Grueber, and printed by order of the Trustees of the British Museum. It is, for obvious reasons, indispensable to every collector of commemorative medals. In my book, "The Royal Miracle," which Mr. Stanley Paul is to publish on May 29th, I hope to give some account of the curious medals and badges worn by the adherents of Charles II between 1649 and the Restoration, many of which after the fateful year 1651 bore the symbol of the royal oak. On January 1st of that year the young King (not yet twenty-one) was crowned at Scone. The gold medal struck on that occasion, which is not illustrated here, is one of the rarest of the English coronation series. Mr. Hawkins thus describes it: "Bust of Charles II, *r.* crowned, hair long, in plain falling collar, ermine robes and collar of the Garter. Legend: "Carolus 2 . D . G . Sco . Ang . Fra & Hib . Rex . Fi . De . *Cor* . *i* . ia . Scon 1651." *Rev.* Lion rampant, *l.*, holding a thistle in his paw. Legend: "Nemo . me . impune . lacessit." In the British Museum there is a leaden medal, believed to be unique, which commemorates the escape of Charles II from Worcester (September 3rd, 1651), and his six weeks' wanderings between that date and his escape from Shoreham to Fécamp on October 15th of that year. On the obverse is a view of the walls and fortifications of Worcester with defenders; outside, Charles on horseback attended by the four Penderels and Yates, and before him a company of soldiers, above, "Woster." Legend: "God – bles – my – Lord Wilmot Lady Lane Col Carter Capt Tedersal." Reverse, sword and olive branch crossed between C. R. Legend: "In – utrumque paratus." It is unnecessary to say that the names thus displayed on it are the names of the principal actors in the enterprise, and whose sterling loyalty mainly contributed to the escape of the King.

FIGURE 204. The great Gold Medal of 1661, commemorating the restoration of Charles II.

It was only two years later, while Charles was still in exile, that the first historic medal now illustrated was issued by the Commonwealth. It is commemorative in its character, but was given by the Government as a reward to Admiral Blake and the other principal naval officers engaged in the battle of Portland and the war against the Dutch. It was struck in two sizes. The specimen illustrated is of the smaller size, and was granted to captains. On the obverse is an anchor from which is suspended three shields charged with the crosses of St. George and St. Andrew, and the Irish harp. Reverse, ships in action. The larger medal granted to senior officers was surrounded by a wide border representing the bow, stem, mast, flags, drums, and arms taken from the enemy: both are in gold, and the work of the celebrated engraver, Thomas Simon. Blake's own medal was purchased by His Majesty, King William IV.

The fine example from which the reproduction has been made is now in possession of Messrs. Spink and is priced at £300. The medal is shewn conspicuously, together with a vignette view of Portland, below the fine mezzotint portrait of Admiral Blake, by Thomas Preston, after a painting belonging to Mr. J. Ames, now in my possession. Below it are the words:—"*Vindex Commercii.*—Robert Blake, General and Admiral of the Forces of England, etc., Denatus

FIGURE 210. John Roettier's Gold Medal [illegible] of Giles Strangways, of Melbury, Dorset, executed after the Restoration, by order of Charles II. Only two examples of this Medal are known to exist.

29 Aug., 1659, ætat 59," and the lines:

Thy name
Was heard in thunder through th' affrighted shores
Of pale Iberia, of submissive Gaul
And Tagus trembling to his utmost source
O ever faithful, vigilant and brave,
Thou bold asserter of Britannia's Fame
Unconquerable Blake.

The battle off Portland was fought on February 18-20th, 1653. The English admirals engaged were Blake, Deane, Lawson, Howett, Monck, Peacock, Martin, Penn, Lane and Bourne. It ended near the Isle of Wight on February 20th, when Blake, reinforced by the arrival of the remainder of the fleet, "re-engaged with great desperation, and after a most valiant fight drove the enemy before him and captured or destroyed eleven ships of war and sixty merchantmen. Fifteen hundred men were killed and seven hundred taken prisoners." Mr. H. Parker, in his "Naval Prints," mentions four small engravings of this engagement, but I have succeeded in discovering a large contemporary Dutch line-engraving measuring fifteen and a quarter inches by twenty-one and a half inches. It is surmounted by portraits of Blake, Penn and Van Tromp, encircled with laurels. In order to avoid possibility of error the rocks in the background are lettered Portland. (See Figure 207.)

FIGURE 211. One of the complete series of the Duke of Monmouth Medals in the collection of A. M. Broadley.

Nearly every county has its historic medals, Dorset being particularly

FIGURE 212. A very rare anti-Jacobite Medal of 1688, ridiculing the birth of the Old Pretender, the legitimacy of whom it calls into question.

rich in this respect. The large Strangways gold medal (see Figure 210) does great credit to the ability of John Roettier, its designer. Copies in gold are in possession of Giles Strangways' descendant, the Earl of Ilchester, and the present writer. The legends on it are sufficiently legible. An account of Giles Strangways, and the part he took in helping the fugitive King during his concealment at Trent (Sept. Oct., 1651) will be found in the "Royal Miracle." This medal, executed after the Restoration, was one of an intended series ordered by Charles II in honour of distinguished sufferers in the royal cause. The design on the reverse of the medal "the White Tower of London surmounted by the Royal Standard, with the sun bursting from behind a cloud," was personally suggested by the Sovereign. Giles Strangways was born at Melbury in 1615, commanded a regiment of horse in the King's service in the West, was persecuted by the Parliament, heavily fined, and imprisoned in the Tower with his father. Mr. Hawkins omits all mention of his generous behaviour in 1651 and subsequent prosperity. George Bower's medal in honour of the Earl of Shaftesbury (1681) also relates to a Dorset worthy, whose lineal descendant and successor still flourishes in the county and holds high office in the State. The design of reverse bears a strange resemblance to that of the Strangways' medal. In Figure 213 we have a view of London from Southwark: the Tower in the distance, and above, the sun bursting from behind a cloud. Dryden made this medal, struck at the instigation of the popular party, who celebrated Shaftesbury's acquittal November 24th, 1681, with great rejoicings and many bonfires, the subject of his well-known satirical poem, *The Medal.* In describing it he says:

FIGURE 213. George Bower's Silver Medal, struck in 1681 to celebrate the Rejection by the Grand Jury of a Bill for the Indictment against Anthony Ashley, Earl of Shaftesbury, for High Treason. The subject of Dryden's Poem, "The Medal."

> "One side is fill'd with title and with face;
> And, lest the King should want a regal place,
> On the reverse a Tower the town surveys,
> O'er which our mounting sun his beam displays.
> The word, pronounced aloud by shrieval voice,
> *Lætamur*, which, in Polish, is rejoice."

and

> "Five days he sat for every cast and look,
> Four more than God to finish Adam took."

FIGURE 214. A Jacobite Medal of the Young Pretender, 1745.

In the six medals connected with the fate of the Duke of Monmouth we find some curious sidelights on the state of English politics in 1685. The tragedy of Sedgemoor began by the landing of Monmouth at Lyme-of-the King in Dorset in June of that year. It was within the confines of the same county that his arrest was effected after his defeat in Somerset on July 6th. Out of these six medals (examples of the whole of which are in the collection of the writer) five ridicule somewhat timidly and obscurely his attempt to gain the crown. The first medal described by Hawkins is the work of Jan Smeltzing. In this we have a bust of the Duke, with long and abundant hair, wearing a breastplate decorated with the fulmen. On the

FIGURE 215. Portrait Medal of Cardinal Henry of York, the last of the Stuarts.

FIGURE 216. Portrait Medal of Princess Louise, the sister of the Old Pretender.

FIGURE 217. A Medal of 1746, issued by the Hanoverians.

reverse is a Roman soldier attempting to tear open a lion's jaw and a Latin inscription which may be translated "It has succeeded little, I have acted diligently." It looks as if the medallist was, up to the last moment, sitting on the political fence. The second medal by Bowers† is more decisive in its tone. Monmouth in trying to seize the three crowns has fallen into the sea. On the reverse (in Latin) are the words "The Gods derided, July 6th, 1685." In the third medal, the work of an anonymous artist, Monmouth is portrayed as falling from a column surmounted by the three crowns, surrounded by military trophies. Above the pillar is the word "Providentia": below, "Improvidentia." There is no date. Hawkins says that "when Monmouth landed in Dorsetshire he proclaimed himself King under the title of James II, and exercised the royal privilege of touching for the King's evil." It may be noted that the example of this medal in the Royal Collection at Stockholm is stamped with the date 1685, and the base of the column is inscribed M. JUL, the month in which Monmouth was defeated and executed. The fourth Monmouth medal in my collection is seen in Figure 211. The bust and hair are arranged very much as in the other specimens. The legend runs: "JACOBUS . DUX . MONVMETHIENSIS." Below are the words, "G . BOWERS . F." On the reverse we see two infant genii amid clouds supporting a coronet over the cypher, J . E . D . M . (James Edward, Duke of Monmouth). There are cherubs above and below. The legend is CAPUT . INTER . NUBILA ("His head is amongst the clouds"). This is capable of various interpretations, but as Bowers worked for the Court, and has put his name to the production, it was probably in derision that he places the head of Monmouth in the clouds. There can be no mistake about the fifth medal, executed by Jan Smeltzing. In this the Duke's hair is short, and there is no drapery. The head is surrounded by the words JACOBUS INFELIX DUX MONUMETHENSIS. On the reverse is the decollated head on the ground spouting out blood and the words, HUNC SANGUINEM LIBO DEO LIBERATORI ("His blood I pour out to God, the Deliverer"). Also CESA CERVIX LON JULY $\frac{15}{25}$ 1685 ("Neck cut, London, July $\frac{15}{25}$, 1685"). This is the least rare of the six medals.

On the last of the series is a bust of James II resting on four sceptres, and so on. Neptune in his car, and ships in the distance. On the reverse is a pedestal inscribed, AMBITIO MALESUADA RUIT ("Ill-advised ambition fails"): on it Justice, trampling on a serpent, weighs three crowns against the sword, the torch and the serpent of Discord. At her feet lie the bodies of Monmouth and Argyle: their heads are on blocks inscribed, JACOBUS DE MONTMOUT & ARCHIBALD D'ARGYL. Above, the Sun: on one side, lightning darting against the forces discomfited at Sedgemoor: on the other are seen two heads fixed over the gate of the Tower. Monmouth was executed on July 30th, 1685. It is curious to note that the royal shield on the obverse has Scotland in the first and fourth quarters as on the Scottish coins. The anti-Jacobite medal, the medal of Princess Louise, daughter of the Old Pretender, the Jacobite medal of 1745, the Hanoverian medal of 1741 and the medal of Cardinal of York, Henry IX of England, according to his tomb at St. Peter's, bring the story of the Stuarts down to its close,* illustrating the strong interest inherent in the study of these striking and instructive memorials of an eventful past—Addison's "Critics in Rust."

*See Figures 212 and 214—217.

QUERIES

Readers are invited to send in Questions and to answer the Queries which are printed here.

4. MENDELISM.—At a recent lecture I attended on "Mendel's Law of Heredity" the lecturer explained how from the union of dominant with recessive the result would be: one dominant, two unaffected transmitters (dominants apparently, but with the faculty of breeding hybrids and recessives) and one recessive. The lecturer illustrated this by the blending of a long pea with a dwarf pea. The offspring would be (in proportion) as follows: One pure long pea; two apparent long peas, but also possessing the germ of the dwarf pea; and one pure dwarf pea.

A gentleman who had not quite understood the lecturer on this point, questioned the latter afterwards, taking as example soft English grain and hard Manitoba grain. The lecturer explained the matter to him, showing how the result would be one dominant, two unaffected transmitters and one recessive, but stated that he could not say which kind of grain would be the dominant.

Now is there any means of telling beforehand in the case of a blend which is going to be the dominant?

Possibly I may make my point clearer if I give another example quoted by the lecturer—the case of a sweet seed and a bitter seed. The result, said the lecturer, would be —(1) one sweet; (2 and 3) two sweets with the power of propagating sweets and bitters and (4) one bitter.

Now in this case the sweet seed is the dominant. Why is this so? Why should not the result have been as follows:—(1) one bitter; (2 and 3) two bitters with the power of propagating bitters and sweets, and (4) one sweet.

To sum up, in the case of a blend, how can you tell (if you can tell), which is going to be the dominant and which the recessive?

S. F. G.

5. ASTRONOMY. In *The Nautical Almanac* under Moon-culminating Stars in the sixth column is given the variation of the Moon's R. A. in one hour of longitude.

I have read what is said in the explanation, and I wish to know, especially by an example from the *N. A.* of 1911 or 1912, how similar figures could be obtained direct; (*i.e.*, without interpolation from those given) for a place, say five and a half hours, in east longitude, instead of at Greenwich.

BERARS, INDIA. A. G. W.

6. WIND PRESSURE. May I ask if some reader of "KNOWLEDGE" would kindly explain why it is that wind records are almost invariably given in terms of velocity, viz., in miles per hour, and are but rarely expressed in terms of pressure, say, in pounds per square foot, which would seem to be more directly and easily ascertained and would certainly be of more practical use, at any rate for the purposes of the engineer. I should also be glad to know if there is any reliable instrument in use which records actual wind pressure exerted on a given flat surface at stated periods.

HYTHE. W. P.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE AQUARID METEORS AND HALLEY'S COMET.—In a recent number of "Knowledge" I referred to Mr. Olivier's observation of the Aquarids and his demonstration of their connection with Halley's Comet. The *Bulletin of the Astronomical Society of Mexico* for March, 1912, contains an article on the same subject by Señor M. M. Marron, from which I quote the following particulars. I have condensed his narrative:

"At half-past three on the morning of May 5th, 1910, an immense ball of fire appeared to proceed from the tail of Halley's Comet. It moved swiftly, lighting up the sky and the landscape.

"According to a telegram from Heredia on the morning of May 10th, 1910, there was observed in the city of Costa Rica a shower of shooting stars, fifty-three being counted in half-an-hour."

Aerolites are also referred to on May 11th, 13th, 18th, but their connection with Halley's comet is doubtful. The one of May 5th appears to have been probably an Aquarid, the radiant being 338 −2 (Denning) near Eta Aquarii; the comet at this time was in 1 +9°, so that its tail would have passed slightly north of Eta.

THE NEW STAR IN GEMINI.—This object was discovered by M. Enebo at Dombaas, Norway, on the evening of March 12th, when it was of the fourth magnitude. The survey plates taken nightly at Harvard Observatory have enabled us to trace its past history, and to say that on the evening of March 10th it was fainter than the eleventh magnitude, while on the following day it had reached the fifth. It took a few days reaching its maximum, when it was distinctly brighter than θ Geminorum, and little inferior to the third magnitude; then a pretty rapid decline set in, and it fell two magnitudes in two days. Like Nova Persei of 1901, the fall was oscillatory; thus, at Cambridge the magnitude was deduced as 5·5 on March 20th, 4·7 on March 25th, 5·5 on March 26th; by the end of the month it was down to the sixth. Its position for 1912·0 is $6^h\ 49^m\ 11^s\cdot75$, N. 32° 15′ 6″; that of Turner's Nova of 1903 for 1900·0 was $6^h\ 37^m\ 48^s\cdot86$, N. 30° 2′ 30″. The two Novae are only some 3° apart: it is rather remarkable to have two outbreaks so closely adjacent within nine years.

Herr Kaiser, of Heidelberg, has found a fifteenth-magnitude star on a Wolf-Palisa plate, taken in 1909, which agrees with the place of the new star within at most 2″. The identity of the two is highly probable but not quite certain. It will be remembered that Nova Lacertae of last year was identified with a fourteenth magnitude star which had been photographed some years before. The spectrum of the new star seems to have been of the F5G, or Procyon, type on March 14th. On the next night the usual bright and dark bands of novae had appeared: these indicated velocities of some six hundred kilometres per second, but the narrow absorption lines gave velocities of recession of twenty kilometres per second. Apropos of the variations in light of the Nova, it is appropriate to refer to the new catalogue of nine thousand eight hundred stars by Mr. T. W. Backhouse. It includes the whole sky from pole to pole, and shows all stars visible to an ordinary eye, including some of the seventh magnitude where there are two stars of that magnitude within a few minutes of arc of each other so that they might be seen as one sixth-magnitude star. The magnitudes have been discussed and reduced to a common system. A map showing magnitudes can be made of any region in a few minutes and the variations in brightness of novae traced from night to night.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

NEW ZEALAND SAND-DUNES.—In continuation of his previous work on the dune areas of New Zealand, Cockayne (*Report, Dept. of Lands, N.Z.*, 1911) has published a detailed and fully illustrated account of his studies on the sand dunes of the colony. For the botanist interested in Ecology in general, this report, consisting of seventy-six quarto pages, with seventy-two plates, and published at the low price of 1s. 9d., is of importance as being the best all-round account of dune vegetation that has yet been published.

After dealing with the geology, topography, and general environmental factors, the author gives lists of the various plants of the dunes, numbering in all nearly one hundred and fifty species, and proceeds to deal with practical methods for the reclamation and preservation of dune areas as farmlands or grazing grounds. The marram-grass (*Ammophila arenaria*) is recommended as the best of the sand-binding plants. Lupins are suitable after the moving sands have been fixed and protected from moving dunes, and for use at a later stage various grasses, and so on, are described. The numerous photographic illustrations show the various dune plants in their habitats, as well as phases in the formation and reclamation of dunes, and so on.

Since the sand dune area of New Zealand extends over about three hundred thousand acres, the question of reclamation is one of national importance, and some action by the Government of the colony is likely to result from Cockayne's investigations and recommendations.

MARSH PLANTS.—The third part of Glück's *Biologische und morphologische Untersuchungen über Wasser und Sumpfgewächse* (G. Fischer, Jena) forms an important contribution to the growing literature of detailed biological Ecology, as distinguished from that of botanical survey work. This third part ("Die Uferflora") deals with over one hundred European species of marsh plants, and extends to over six hundred pages, with eight fine double plates and over one hundred text-figures.

The author describes in detail the various forms of marsh plants, according to whether they develop under their optimum conditions of growth (with the roots in water or saturated soil and the shoots in the air) or under less favourable conditions (submerged in deep water, or on the other hand stranded on a dry substratum). The fresh-water flora is divided into three zones:—(1) submerged flora, (2) floating-leaf flora, (3) marsh flora. The last named is again divided into two classes—one including plants which are adapted rather for life in air, *e.g.*, *Typha, Acorus, Iris, Caltha, Menyanthes*; and the other including plants adapted more for aquatic life, under which heading come the great majority of marsh plants. In the first class, the plants when growing in water suffer reduction of all the vegetative parts; while the plants of the second class (*e.g.*, *Peplis, Scirpus, Littorella, Ranunculus lingua, Oenanthe fistulosa*, and many others), on the contrary, show increase in their vegetative parts when growing in water.

Glück pays special attention to the various forms of the leaves of marsh plants. He adopts Goebel's distinction between "homoblastic" types with only one form of leaf, and "heteroblastic" types, in which the primary and the later leaves differ in form. In cases where submerged leaves are formed, differing from the aerial leaves, the former are of a primary type. It seems a pity that the author has not dealt with the minute structure of the various leaf-forms which he describes, but apart from this he brings together an enormous amount of information concerning the morphology of both vegetative organs and flowers, periodic phenomena, vegetative reproduction, germination, and other aspects of marsh vegetation, including much that is new. One of the most remarkable plants which he describes is an aquatic dodder, *Cuscuta alba*, which grows as a submerged parasite on various water plants in Sardinia and Algeria.

VEGETATION OF CAITHNESS.—In *The Vegetation of Caithness considered in relation to the Geology*, C. B. Crampton has published, under the auspices of the Committee for British Vegetation, a most important and interesting study of vegetation as developed under the influence of geological and physiographical factors. In the Preface, Dr. W. G. Smith, who has done so much pioneer work in botanical survey — along with his brother, the late Robert Smith, he laid the foundations of systematic field-work and mapping of vegetation in Britain — points out that this memoir on Caithness proceeds beyond a mere description of the vegetation. While this descriptive work has been the main theme in the successive memoirs published by R. and W. G. Smith, Smith and Rankin, Moss, Lewis, and others, "there has been an increasing tendency to consider other aspects of the ecological grouping of plants. In each area dealt with, new plant-communities have been discovered and compared with other known types, both as regards floristic composition and ecological characters. It has been more and more realised that some ecological groups are of a higher order than others, and so have arisen the concepts of a greater unit, the plant formation, and lesser units—subformations, associations, societies, and so on. The relation existing between plants associated together in plant-communities, and the habitats occupied by each vegetation unit, has received greater consideration in each successive memoir."

As Dr. Smith points out, this Caithness memoir is the first attempt by a member of the Geological Survey to deal with the vegetation of an area on which he has worked, and this is especially welcome since in former botanical surveys sufficient attention has not been paid to the geological considerations bearing on the topography or physiography of the district dealt with. The chief theme underlying this memoir is the distinction of stable from unstable formations, and such topics as the influence of physiographic factors on the historical development of the vegetation, and the effect of glaciation on plant distribution, are discussed in a way not hitherto attempted.

The author discusses in detail the conditions determining the formation of peat since early post-glacial times, and the changes in the vegetation of the peat leading on to the present period of retrogression—about two-thirds of Caithness are now covered by peat, which was formerly much more extensive. The accumulation of peat has been favoured by (1) the plateau-like topography and its influence on the prevalent winds, rainfall, and drainage; (2) the condition of the surface of the land at the retreat of the ice-sheet, when the surface was either bare rock or drift, the soil-bacteria that promote nitrification were banished and returned slowly owing to the cold and the accumulation of acid humus, and stagnant conditions alternated with hard unweathered surfaces of rock or boulder-clay; (3) the latitude of Caithness and its geographical position relative to the edge of the continental shelf.

The subsequent history of the vegetation is indicated by plant-remains in the peat. "At first the plant associations were probably of a tundra-like nature, shallow-rooted, creeping, or cushion-like, and periodically frozen or soaked in ice-cold water. As the cold grew less, and more humus accumulated, a bog flora established itself in the hollows, but over wide areas a dwarf scrub of birch seems to have obtained a footing." Later came a forest period with pines, which subsequently disappeared, their advent and decline being attributable probably to climatic changes. In recent times the occurrence of extensive areas of peaty moorland has acted as a barrier on the landward side to all plants incapable of competing with moorland associations, hence plant-migration has taken place mainly along the coast and river systems, and by the aid of man.

The author proposes that dominant plant formations which occupy ground comparatively stable from the geological standpoint should be termed stable or *palaeogeic* formations, since the ground they cover mainly owes its features to past geological processes; while for the limiting and dissecting formations, often found in all stages of progressive association and succession, from the migratory nature of the geological agents of erosion and deposition, he suggests the terms migratory or *neogeic* formations, since the ground they occupy owes its features to recent geological processes. In the case of Caithness, this method resolves the vegetation into one dominant stable formation, the moorland, and several migratory formations in the belts along the coast, the ramifications of the drainage system, and the alpine centres. These various formations are then dealt with in detail, with numerous examples of associations in representative localities.

The author links up his classification with that of Cowles, who has defined three types of cycles of vegetative succession (1) regional successions, due to secular change, the most important in Britain being the post glacial invasion of southern forms into northern regions, accompanying and following the retreat of the ice; (2) topographic successions, of much greater rapidity and associated with topographical changes resulting from the activities of such agents as running water, wind, ice, gravity, and leading in general to erosion and deposition, the influence of erosion being generally destructive to vegetation or at any rate retrogressive (tending to cause departure from the mesophytic type) while that of deposition is constructive or progressive (tending to cause an approach towards the mesophytic type); and (3) biotic successions, due to plant and animal agencies. The regional successions are exemplified in Caithness in successions of plant remains, tundra, forest, and moorland, in the peat-mosses, such as were first demonstrated in Denmark by Steenstrup and recently in Britain by Lewis; the plant formations effecting these regional successions correspond to Crampton's stable or neogeic formations. The topographical successions (normally limited to the coastal belt, river systems, and alpine centres) and the biotic successions are included in Crampton's migratory or neogeic formations.

Altogether, this memoir may be said to break a good deal of entirely new ground as regards descriptive ecology in Britain. A notable feature in the author's thorough and instructive treatment of the vegetation of his area is the inclusion of the more abundant and characteristic mosses, liverworts, and lichens in his floristic lists, and his demonstration of the important part played by these plants in the various associations. The importance of the peat-mosses (Sphagnaceae) has, of course, long been realised, but comparatively little attention has been paid by previous writers on descriptive ecology to other mosses which, along with lichens and hepatics, enter largely into the composition of various plant-societies and in places form a striking and conspicuous element in the vegetation. For instance, Crampton distinguishes a Rhacomitrium bog association, in which the woolly fringe-moss (*R. lanuginosum*) is dominant over considerable areas. It is characteristic of the author's thoroughness that he has not been content with "*Sphagnum* spp.," but has had his sphagnums named, as well as the lichens and liverworts. In connexion with the latter group, mention may be made of Macvicar's recent work on the distribution of the liverworts of Scotland.

IRON BACTERIA.—Our knowledge of these remarkable organisms, largely due to the work of Winogradsky and of Molisch (see "KNOWLEDGE," March, 1911, page 105), has recently been supplemented by Lieske (*Jahrb. für wiss. Bot.*, 1911). This writer has studied *Spirophyllum ferrugineum*, which, unlike *Leptothrix* studied by Molisch, does not grow in a medium containing organic matter, nor in an iron-free medium, nor in a medium containing iron salts other than ferrous carbonate or bicarbonate, nor salts of any of the other metals. Lieske's most important result, however, is his experimental proof that this bacterium can utilise the carbon of carbon dioxide in the total absence of any other source of carbon. The nutrient medium contained inorganic salts in solution, [illegible] supplied to the extent of [illegible] in the [illegible]. With inorganic salts, metallic [illegible] of carbon than that supplied [illegible] of carbon dioxide on the iron-forming [illegible] there was a marked increase in the carbon content of the culture, masses of the bacterial filaments being [illegible] growth. The bacterium must, in order to [illegible] produce from the ferrous carbonate [illegible] seven hundred parts of ferric oxide.

Carbon dioxide is utilised in a similar manner by various other oxidising bacteria, such as the nitrate and nitrite bacteria, those which convert thiosulphates into tetrathionic and sulphuric acids, those which split up hydrogen peroxide, and those capable of oxidising methane and carbon monoxide and utilising the carbon these substances contain.

CHEMISTRY.

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

RADIUM IN THE WATERS OF BATH.—It has long been known that artificial preparations of mineral waters do not always produce the same effects as the natural waters, however closely they are made to correspond in their chemical composition. The chemists of the eighteenth century accounted for this by the theory that natural mineral waters contained a certain vital principal, "the soul of the waters," to which they owed their specific activity, and later this volatile principle was identified with carbon dioxide, or "fixed air," as it was then termed. During the last century there was a tendency to attribute the cures apparently effected by certain classes of mineral waters, in which nothing remarkable could be discovered, to the simultaneous effects produced by good air and regular diet which accompanied the "taking of the waters."

In 1895 the element helium was discovered, and a few years later the gas was found to be a constituent of many natural mineral waters. It was, for instance, shown to be present in the gases escaping from the King's Well at Bath, in the proportion of 1·2 parts per thousand, but the significance of this fact was not made clear until in 1903 there came the discovery by Sir William Ramsay and Mr. Soddy that helium was a product of the disintegration of radium, and that its presence in the water was thus an indication of radioactivity.

The presence of radium itself was detected by the Hon. R. J. Strutt both in the waters of Bath and in the deposits from the hot springs, and this has been followed by the recent estimation by Sir William Ramsay of the amounts of niton (radium emanation) in the different waters of Bath and the gas emitted by them.

The report of this investigation is published in a recent issue of *The Chemical News* (1912, CV., 134), and the interesting results there given have an important bearing upon this question of the therapeutic action of waters like those of Bath.

The gas emitted from the King's Well was estimated to amount to four thousand nine hundred and twenty-seven litres in twenty-four hours, and consisted of three hundred and sixty parts of carbon dioxide and nine thousand six hundred and forty of nitrogen, and so on, per ten thousand. The nitrogen contained 73·63 per cent. of argon, 23·34 per cent. of neon and 2·97 per cent. of helium.

The Pump Room water contained in solution 18·5 parts of gas per thousand, consisting of 6·9 parts of carbon dioxide and 11·6 parts of nitrogen and its companions.

In measuring the amounts of radium and its emanation (niton), the latter was calculated into the corresponding quantity of its parent, radium, that would have produced it. The method may best be made clear by quoting Sir William Ramsay's words: "Suppose one gramme of radium to be dissolved in water, say as chloride or bromide. It is continually giving off niton, but at the same time the niton is as continuously disappearing with the formation of radium A, B, C, and D. There will arrive a time when the production of niton from the radium will have ceased to increase, because as it is produced it decays, and the rate of production is then equal to the rate of decay. The amount of niton will therefore increase up to a certain point; that point is when 0·6 of a cubic millimetre of niton has been produced. The weight of one cubic millimetre of niton is almost exactly one hundredth of a milligramme; hence 0·6 cubic millimetre weighs six thousandths of a milligramme. This is the weight of niton which is in equilibrium with one gramme of metallic radium."

Estimated by this method the following results were obtained in the examination of the waters of Bath:

	[illegible]*
Radium in the water of the King's Well ...	0·1387
Niton (radium emanation)	1·73
Niton .. .. .. Cross Bath ...	1·19
Niton .. .. .. Hetley Bath...	1·70
Niton .. in gases from King's Well ...	33·65

* These figures are the weights of radium capable of forming the amounts of niton found.

EFFECTS OF ROAD SURFACINGS ON FISH LIFE.—The modern method of tarring roads to prevent dust has led to numerous complaints that fish in streams near the road have been destroyed by the poisonous dust. An investigation to ascertain the effects upon fish of various compounds present in substances used for treating roads has, therefore, been made by Mr. W. A. Butterfield (*Surveyor*, 1912, XLI, 277). From the results of the experiments it appears that ammonia and many of its salts, gas liquor solutions, phenols and tars containing much phenol, and light tar oils capable of forming films on the surface of the water, are all more or less toxic to fish. On the other hand, napthalene, coal-tar, pitch, and certain kinds of asphaltum are not distinctly injurious to fish, while there is no objection to the use of calcium chloride solutions. Films of heavy automobile oil on the surface of the water have also no injurious action upon the fish.

The general conclusions based upon these experiments is that the tar for allaying the dust in roads should consist of coal tar or a mixture thereof with carburetted water-gas tar, with a specific gravity of not less than 1·18 at 15° C., and that it should contain not more than one per cent. of gas liquor (the ammonia in which must not exceed five grains per gallon of tar), one per cent. of light oils, and three per cent. of crude tar acids. This will ensure safety to fish life, provided that not more than a twentieth part of the area draining into the water has been tarred.

Incidentally it is pointed out that there is some risk of injury to fish from the washings from stable manure finding their way into the water, and that for the same reason the use of sodium nitrate as a fertilizer is attended with less chance of injury to fish than the use of ammonium sulphate.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

THE GEOLOGY OF THE COUNTRY AROUND OLLERTON.—A Survey Memoir just issued with this title describes the country between Newark and Mansfield, Nottinghamshire. The ground is mostly occupied by Triassic rocks, with small tracts of Permian and Lias, all being underlain by Coal Measures which, although not exposed in the Ollerton district, are continuous with the visible Coal Measures in the adjoining area to the west. The extent and availability of the concealed coalfield is, of course, the chief economic interest of the area.

The Permian rocks were deposited on an evenly denuded slope of Coal Measures, directed nearly due east and falling at the rate of one hundred and ten to one hundred and twenty feet per mile. A considerable thickness of Coal Measures was lost by denudation before the deposition of the Permian rocks. The coal seam usually sought for in borings is the Top Hard. In the Mansfield Colliery workings, this seam dips three degrees (276·7 feet per mile) to the north-east. If this dip continues within the Ollerton district, the Top Hard Coal would plunge below the limiting depth of profitable working (4,000 feet) in the area bordering on the Trent. To the south and west of the Ollerton district, however, the dip is known to decrease north-eastward until it is a little over a degree (92·16 feet per mile). If this lowering of dip continues to the east and north-east of Mansfield, the Top Hard Coal may be found at workable depths throughout most of the area described in the memoir.

COPPER NICKEL ORES IN EAST GRIQUALAND.—A great nickel-bearing intrusion, very similar to that of the famous Sudbury district of Canada, has been found at Insizwa, East Griqualand, and has been described by A. L. Du Toit in *The Fifteenth Annual Report of the Geological Commission of Cape Colony* (1910). The intrusion consists mainly of gabbro, with olivine- and hypersthene-bearing varieties, intruded into the shales and sandstones of the Beaufort Series, which it has intensely metamorphosed. The chief ore minerals are pyrrhotite, chalcopyrite, and pentlandite. The latter, of course, is the chief nickel-bearing mineral, but the other two are also slightly nickeliferous. These ores are confined more or less to the contact of the gabbro with the hornfelsed sediments, impregnating the latter to a small extent, but becoming more abundant in, and sometimes restricted to, the igneous rock, of which the sulphide ores appear to be primary constituents.

As in the Sudbury district, the Insizwa intrusion forms a huge basin-shaped mass; but the shape is original, and is not due, as at Sudbury, to the sinking of the sediments in the basin. The strata have been intensely altered, in some places to a depth of two hundred feet below the intrusion. The resulting hornfels is much mixed up with the gabbro near the contact, and is also penetrated by strings and patches of granitic rock. The copper-nickel ores occur along the lower contact of the gabbro, and never more than a few feet away from the igneous rock.

The gabbro must be regarded as the source of the ore, for a petrological examination of the ore-bodies shews that the ores formed a portion of the once molten magma, and that during the cooling they segregated towards the lower margin of the mass, impregnating the adjacent strata to a small extent. The order of crystallization of the chief ore minerals is (1) Chalcopyrite, (2) Pentlandite, (3) Pyrrhotite. The olivine and pyroxenes in the igneous rock are beautifully fresh, and are idiomorphic to the ores; but the latter appear to have crystallized along with the biotite. In places the ore is moulded on the biotite, in others it is intergrown to a small degree, but commonly the biotite forms a fringe around the ores. No veins of sulphide ore are to be found penetrating the gabbro minerals as one would expect had water deposition been the agent of their formation.

There is every stage from a gabbro or norite with minute scattered particles of ore to a rock in which ore and silicates are in equal proportions, and finally to an almost pure ore with a few patches of silicates scattered through it. The pure ore-bodies are usually sheet-like in form, and are roughly parallel to the adjacent contact, grading into normal gabbro. There is a gradual decrease of basicity in the mass from the bottom to the top. Towards the top the rock becomes olivine-free, and a quartz-felspar micropegmatite is developed.

It is to be hoped that future mining developments will show that the Insizwa Range is similar to the Sudbury district in the richness of its ore-deposits, as well as in their form and genesis.

THE DATA OF GEOCHEMISTRY.—Dr. F. W. Clarke and the United States Geological Survey deserve the thanks of all geologists for the second edition of "The Data of Geochemistry," issued recently as Bulletin 491. All that relates to the chemistry of geology is here dealt with in detail, and the geologist will be no less thankful for the scope of the work than for the extremely full references to the vast and widely-scattered literature of the subject. Originally issued in 1908 as Bulletin 330, the book is now revised, enlarged and brought thoroughly up-to-date. The petrologist and mineralogist, as well as workers in other branches of the science, will find in this book a perfect mine of facts relating to the chemical side of their study.

THE MESOZOIC ROCKS OF KENT.—The mesozoic rocks obtained in four of the principal borings for coal in Kent have been examined in great detail by Messrs. G. W. Lamplugh and F. L. Kitchin, of the Geological Survey, and the results published in a recent Survey Memoir. A knowledge of the range and character of the Mesozoic rocks in the south-east of England is of much importance as bearing on the prospects of finding coal at a workable depth in the Palaeozoic floor which underlies the area. Such investigations lead to conclusions as to the thickness of rock to be penetrated before the coal-bearing strata are reached, and may afford indications as to the localities where borings may be undertaken with the most profitable results. Four borings, at Dover, Brabourne, Pluckley, and Penshurst, ranging on an east-west line of forty-five miles, are described.

Some very important results have been obtained, which have no little bearing upon the economic problem. The Lower Cretaceous rocks underground vary considerably from their outcrop characters. At Dover the palaeontological evidence establishes an unconformity between the Hastings Beds and the Kimmeridge Clay, only the lower part of the clay being represented. To the west, however, the upper part of the Kimmeridge Clay is so greatly developed that the Penshurst boring failed to penetrate to its base. This thickening is shared by all the Jurassic and Lower Cretaceous strata, and indicates a long-continued depression in this region. The downward movement ceased before the deposition of the Upper Cretaceous, and the Wealden anticline has since been superimposed upon the whole area. Characters indicative of a shore-line to the north-east have been observed in several of the Jurassic rocks.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended March 16th, as set out in the Weekly Weather Report of the Meteorological Office, was generally unsettled, although in some places no rain was recorded. Thunder was heard in Hampshire on the 15th, and sleet or snow was experienced in Ireland towards the end of the week.

Temperature was considerably above the average in all districts, but only in Ireland, S. did the maximum reach 60°. The highest readings were 63° at Foynes and Killarney on the 13th, with 62 at Kilkenny, and 61° at Cahir. In Jersey the maximum was only 57°. The lowest readings were below freezing-point in all districts except Ireland, N. and the English Channel. The lowest of the minima were 21° at Balmoral and 25° at West Linton. On the grass the temperature fell to 18° at Balmoral and to 19° at Newton Rigg, but at depths of one foot and four feet the earth temperature was higher than usual in all parts.

Rainfall was below the average in Scotland, N. and E., and just equal to it in England, E. and S.E. In all other districts it was in excess, though not as a rule to any great extent. Sunshine was slightly above the average in Scotland, N., and Ireland, S., but below it elsewhere. The district values varied from 1·6 hours per day (13%) in England, E., to 3·8 hours per day (33%) in Ireland, S. At Westminster the average duration was 1·2 hours per day, or 10 per cent. of its possible duration.

The temperature of the sea water round the coasts varied from 40° at Berwick and Scarborough to 51° at Scilly.

The weather of the week ended March 23rd was very unsettled. Over a large part of the Kingdom precipitation occurred every day, generally in the form of rain but sometimes in that of sleet, snow or hail.

Temperature was not far from the mean but was below the average in most districts. Frost was experienced in all districts except the English Channel. The lowest readings reported were 23° at West Linton, and 26° at Fort Augustus. In Jersey the minimum was 35°. The highest maximum was 60° at Killarney, the next highest being 55° at Cambridge and Cirencester. On the grass, readings down to 19° at Ranceby and Newton Rigg and 20° at Worksop were reported, while the temperature of the earth, both at one foot and at four feet depths was from 2° to 3° higher than usual.

Rainfall was above the average in all districts except Scot-

[illegible] N. and W. [illegible] England, S.E., [illegible] [illegible] readings were also in England, E., being 69° at [illegible] On the 9th [illegible] Geldeston on the 6th, and 68° at Cambridge, [illegible] Round [illegible] same day. In Jersey the [illegible] reading was only 57°. In spite of [illegible] maxima frost was reported [illegible] except the English Channel. The lowest readings were [illegible] on the 2nd at West Linton and Llangammarch Wells. On the grass the lowest reading was 19° at Worksop; 20° was reported at a number of stations. At one foot and at four feet below the surface the ground was still warmer than usual, but the excess was less marked than in previous weeks.

[illegible] per cent.

[illegible] temperature of the sea [illegible] and [illegible]

[illegible] The week ended March [illegible] over the south [illegible] of the Kingdom, but [illegible] frequently [illegible] Thunderstorms occurred on the [illegible] and 30th, and showers of hail [illegible] or snow were reported [illegible] stations late in the week.

Temperature was above the average in all parts, by as much as 7°·1 in England, E., and maxima of 60° and [illegible] were common. The highest readings were 6[illegible] at Norwich, Geldeston, Raceds and Margate on the 25th. The minima were as a rule much [illegible] than in the preceding week, and readings below freezing were reported only in Scotland, E., where minima of 28° were observed at Nairn and Balmoral. In Guernsey the lowest reading was 43°. On the grass the lowest reading recorded was 22° at Buxton. The earth temperature was again higher than usual. Rainfall was in excess in Scotland, England, N.W., and Ireland, N., but in defect elsewhere. In Scotland the amounts collected were in many instances more than twice as much as usual. At Glencarron and at Fort William the total for the week exceeded three inches. Sunshine was in excess in Scotland, N. and the Eastern districts, and in defect elsewhere. In Scotland, E. the average was 5·7 hours per day, or 45 per cent., while in Ireland, N. it was only 2·5 hours or 20 per cent. At individual stations the contrast was still more marked, Aberdeen having 6·4 hours per day (51 per cent.), while Valencia had only 1·8 hours per day or 15 per cent.

The temperature of the sea water ranged from 41° at Berwick and Scarborough to 52° at Scilly.

The week ended April 6th, was generally fair except in the N. and N.W. Early in the week sleet and snow showers were experienced over a considerable area. Temperature was again above the average in all districts, the greatest excess being 3°·8 in England, E. The highest

Rainfall was more than three times the average in Scotland, N. In Scotland, W. it was also in excess, but in Scotland, E. it was normal, and in all other districts it was in defect. In the Midland Counties and in Ireland N. the total fall was less than one third the usual amount. Sunshine was above the average in England, E., S.E., and N.W., and in the Midlands, while in Scotland, W. it was normal, and in the other districts it was in defect. The sunniest district was England, S.E. with an average of 5·9 hours per day (46%); the sunniest station was Margate with 7·1 hours per day (55%). At Westminster the average was 5·0 hours per day (39%). The mean temperature of the sea water varied from 41·4 at Berwick to 51·8 at Scilly.

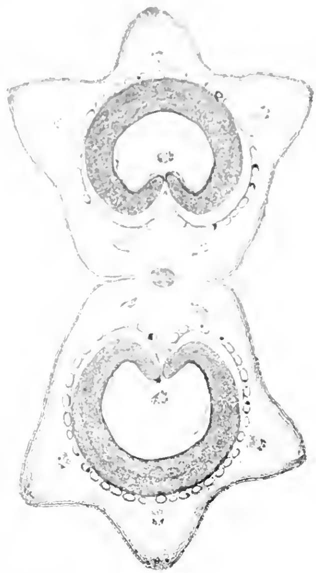


FIGURE 218. Transverse section of the double fruit of *Smyrnium*.

[illegible] Figure 219.

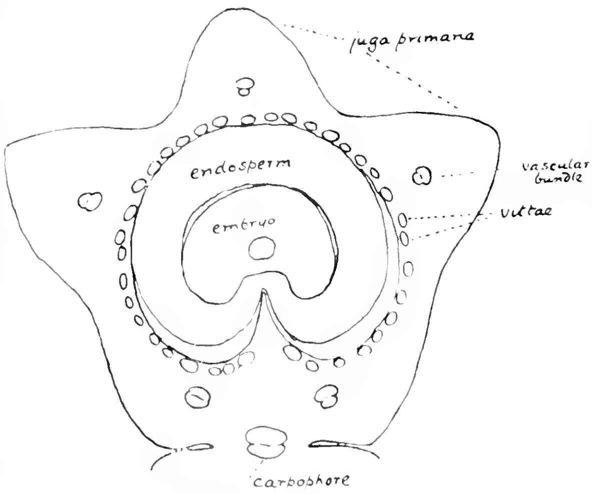


FIGURE 219. Key to Figure 218.

MICROSCOPY.

By F.R.M.S.

FRUIT OF SMYRNIUM. The structure of the fruits of Umbellifers (parsleys, carrots, hemlocks, and so on), is particularly well seen in microscopical sections, and it would be interesting to form a collection of such preparations illustrating our native species. Some of the leading characters may be seen in Figure 218, taken from a photomicrograph of a transverse section of the double fruit of *Smyrnium*. Externally there are in this form three prominent ridges on each half of the fruit, the two internal ones blending with the corresponding ridges of the opposite side. Inside these we find the five vascular bundles; these ridges are therefore *juga primaria*, *juga secondaria* being ridges not corresponding in position to vascular bundles. (Figure 220 shows the relation of bundles to ridges in the stem of the sunflower.) We note also the centrally-placed *carpophore*; the *vittae*, or oil canals, in this instance closely surrounding the endosperm, which encloses the *embryo* (see also Figure 219). By some authors the order is classified according to the form assumed by the endosperm: in this case it appears in section twisted round, like a coiled-up caterpillar, and we refer our specimen to the group Campylospermeae. The most familiar character of these "seeds" is their strong smell, due to the oil contained in the vittae, in most species. The well-known cymene phenol carvacrol, which can be made by boiling camphor with iodine, owes its name to *Carum Carui*, carvol (carnol) having been the term applied to the oxidised constituent of carraway oil, carvene (carnene) being the hydrocarbon. Pliny (N.H. 23: 88) says that *oleum caryinum* is good for headache, so that it is possible that a substance allied to thymol was used for similar purposes in classical times; marjoram is used to anaesthetise Iulus in Aen. I. 692. Pliny indeed connects his *oleum caryinum* with *nux juglans*, but this is probably because he connects it wrongly with caryon, "a nut," the real word being caron and its adjective caroinon, whence wine and nuts have wrongfully attached themselves to the carraway throughout its literary history. Many of the terpenes seem to have been known to the ancients, and if we could get them correctly identified we might think better of the empiric medications of those distant days. The specific name *Carui*, given by Linnaeus, seems to be a latinisation of the vernacular name as still used in several European countries; and this itself is derived from Pliny's term, the mistaken orthography being shared by no less a person than Galen. To return to the twentieth century: these fruits, when duly fixed, are not difficult to sectionise, if care be taken to bring them to the right consistency; perhaps the best way is to embed them in paraffin, and cut them like ordinary histological sections, since in this case the block remains as a source of further specimens if such should be desired. The photographs were taken with the Zeiss thirty-five millimetres projection lens, illuminated with the Kohler system and the back of the aplanatic condenser.

E. W. BOWELL.

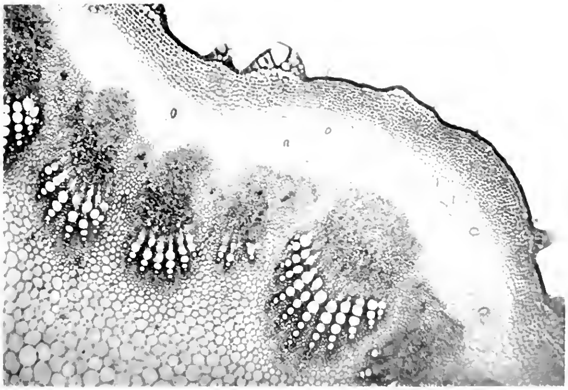


FIGURE 220. Cross Section of the Stem of Sunflower.

QUEKETT MICROSCOPICAL CLUB.

March 26th, Professor A. Dendy, D.Sc., F.R.S., President, in the chair. Mr. E. M. Nelson, F.R.M.S., exhibited "An Aplanatic Spot Lens." This, recently made by Messrs. Baker from his calculations, focusses parallel rays directly upon the object. Its N.A. is 1·3 and its focus eight millimetres. It is a single lens with a convex reflecting surface, which is also a concave refracting surface, the latter introduced to neutralise the aberration of the concave mirror.

Mr. Nelson also described "An Improved Chromatic Condenser." Owing to the many faults of the ordinary Abbe condenser it was suggested that it would be well to have a simple form of non-achromatic dark-ground illuminator that would be capable of doing real serviceable work, and also for ordinary work a cheap narrow-angled chromatic condenser with spherical aberration at a minimum. The first had already been done and was exhibited and described at the meeting of the Club in March, 1911. The new condenser now exhibited is a non-achromatic triple of 0·65 N.A. and of minimum aberration. It is composed of two menisci and one bi-convex.

A third paper by Mr. Nelson on "The Rousselet Compressor" was also read.

Mr. Earland brought before the Club's notice a very important paper on "The *Lagenae* of the South West Pacific," contributed to the Club's *Journal* by Mr. Henry Sidebottom.

Mr. C. F. Rousselet, F.R.M.S., made a communication on *Notholca triarthroides* Skorikow, *Cathypna brachydactyla* Stenroos, and a new *Brachionus* from Devil's Lake, North Dakota, U.S.A. The new species was *B. spatiosus*, found in plankton material collected by Professor R. T. Young, in July, 1910. In shape and appearance the nearest forms are *B. latissimus* and *B. longipes* of Schmarda.

Mr. D. Bryce read a paper on three new species of *Callidina*. These were *C. nana*, *C. concinna*, and *C. decora*.

Mr. A. E. Conrady, F.R.M.S., read a paper on the resolving power obtainable with dark-ground illuminators. The *full* resolving power of an objective was only obtained when the dark-ground illuminator had three times the numerical aperture of the objective obtainable, or, stated in another way, the resolving power was equal to one-fourth that of the objective plus one-fourth that of the condenser. No higher resolving power can be obtained with dark-ground than will be given with an objective having a N.A. of 0·47.

Mr. A. A. C. Eliot Merlin, F.R.M.S., sent a note on a photograph of the secondary structure of *Navicula Smithii*. The photograph showed the structure described at the meeting of the Club, October 18th, 1907, and, the writer thought, left no reasonable doubt as to the objective reality of the markings observed. The photograph was taken at a direct magnification of ×2,900 with an apo. $\frac{1}{8}$th inch of 1·42 N.A. and an axial cone of 0·5 N.A.

Dr. T. W. Butcher sent a series of ten photomicrographs of

FIGURE 221. Section of the Thorax of a young Rat.

the [illegible] method [illegible] of [illegible] [illegible] [illegible] dot [illegible] [illegible].

KERNSCHWARZ.—In photomicrography [illegible] contrast may be obtained [illegible] green and bathed post method. But, in practice it is possible. I prefer to stain the [illegible] for this particular purpose [illegible] ordinary process plate with a Bolt Court developer. Kernschwarz, recommended long ago for this purpose by Bolles Lee, is an excellent stain for such specimens. It is especially good when one desires to show sharply and distinctly the general appearance of a section. Figure 221 is a section through the thorax of a young rat done by this method; lungs, oesophagus and vagi, aorta, thoracic duct and pleurae will be readily recognised. Carmine preparations are much less satisfactory; one is shown in Figure 222 (vermiform appendix, injected).

F. W. B.

ARRHENURUS INSULANUS KOEN.—In August, 1894, I found in a small pond in the Warren, Folkestone, a beautiful dark red female Arrhenurus, which I could not identify. It is always very difficult to identify a species of Arrhenurus from the female as the females are so much alike. With the males it is comparatively easy because they all exhibit a distinct structure from one another. In 1896, I again visited the same pond and did all I could to find a male or at least more females, but I had no luck. I can only conclude that during the two years the pond had been dried up, and in that case all the Hydrachnids that were there in 1894 had died out, so when I published my list of Water Mites found in the Warren in 1894 and 1896 I mentioned that I had found one particular female Arrhenurus I could not name for want of the male. (See Figure 223.)

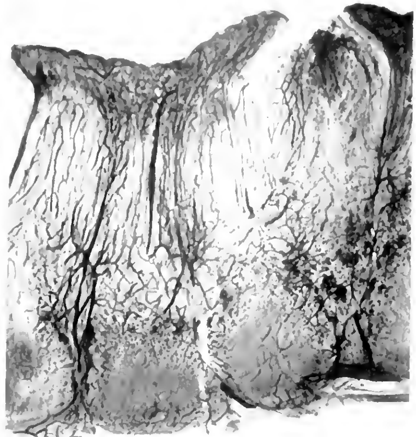


FIGURE 222. Vermiform appendix, injected.

In October, 1899, Mr. Halbert, of Dublin, sent me a female he had found in Ireland, which on examination turned out to be the same species, only this specimen was not quite fully developed. Here again the male was not taken, so it still went unrecorded and unnamed.

FIGURE 223. *Arrhenurus insulanus* Koen. Ventral surface of the female × 19.

In 1911, Dr. F. Koenike, of Bremen, found the same species in North Germany, but curiously enough the male was still wanting. Dr. Koenike is one of the greatest authorities we have on the Hydrachnidae, and was sure it had never been named, so named it at once as *Arrhenurus insulanus*. There is always a certain amount of risk in this because we have several male Arrhenurus which have been named, but at present do not know the proper females to place with them. This particular female, however, although of the usual shape, has very unusual genital plates, as can be seen in Figure 224.

FIGURE 224. The genital area of the specimen seen in Figure 223 × 40.

I take this opportunity to place the name *Arrhenurus insulanus* Koen. on the British list. But the object of this note is more with the idea of [illegible] some [illegible] pond-hunter [illegible]. The [illegible] find the fellow [illegible] by the [illegible] of the female and if beautifully coloured, must be a very handsome creature.

CHAS. D. SOAR.

A PARASITIC ALGA.—I have received through a friend at the Quekett Microscopical Club some portions of leaves of *Arisarum vulgare* attacked by the parasitic alga *Phyllosiphon arisari*. On holding a piece of the dried leaf up to the light, it is noticed that the chlorophyll, in the worst cases, is destroyed in the neighbourhood of the alga, leaving a colorless and partially transparent spot, in which, after preparation and examination under the microscope, it is evident that the internal structure is broken up, little indeed remaining but the upper and lower cuticles even they being in a more or less disorganized condition and the vascular bundles. Between the cuticles the filaments of the alga can be seen ramifying, radiating from what is probably the centre of infection. It is noticeable that where a vascular bundle crosses the leaf, the filaments are checked in their progress (see Figure 225 A). They proceed chiefly in the intercellular spaces of the spongy parenchyma, absorbing the protoplasm and chlorophyll on the way, at last destroying the cells also. The alga consists of much branched tubes, from about 25 to 40μ diameter; they have firm walls and are filled with protoplasm, in which are very numerous small oval green chloroplasts about 2½μ in their longest diameter; many nuclei are present. From the fact that the plant possesses chlorophyll of its own in abundance, it may be concluded that it is only partially parasitic, but it no doubt obtains its water, mineral and nitrogenous elements from the host, although most likely it is able to fix CO_2 for its requirements. The characteristic feature is that, although of very considerable length the tubes have no cross walls; each has a continuous cavity for its whole length, and may be looked upon, therefore, as one cell only, and the plant notwithstanding its size is unicellular. This peculiarity has caused it to be classed with the *Siphoneae*. The very common alga *Vaucheria* belonging to the order has the same feature and indeed *Phyllosiphon* closely resembles a delicate specimen of *Vaucheria*. Just as in that plant too, owing to the absence of dividing walls, if a filament is cut or injured, the contents escape, leaving nothing but the empty tubular wall, of which several examples may be seen in the figure. I have not been able to find out anything respecting its reproduction, and in my specimens, of course somewhat suffering from the drying, there is no sign of anything of the kind.

nor any appearance of [illegible] on the surface of the leaf. [illegible] preliminary [illegible] is mostly tropical, and [illegible] species are [illegible] on the leaves of [illegible] but the one [illegible] is found [illegible] of Italy, and [illegible] South of France. Figure 225 A is portion of leaf, slightly magnified, showing the course of the filaments, in B some are dissected out, giving their general appearance; at the bottom is a piece of the partially disorganized lower cuticle with the parasite spreading from the remains of the leaf cells, × about fifty.

JAS. BURTON.

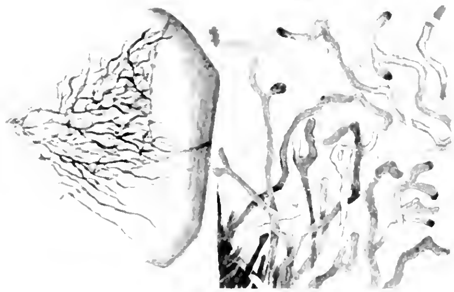


FIGURE 225.

A. [illegible] infected with *Phyllos* [illegible]
B. Filaments dissected out × 50 (approx.) [illegible]

ROYAL MICROSCOPICAL SOCIETY. March 20th, 1912. Edward Heron-Allen, Esq., F.L.S., Vice-President, in the chair.

Mr. C. F. Rousselet described a Lieberkuhn Microscope which had been presented by Mr. Alpheus Smith. Lieberkuhn devised this form of microscope about 1738; it was intended principally for viewing opaque objects which were illuminated by a silver concave speculum in the centre of which was mounted a biconvex lens. The combination of a lens and reflector was invented by Descartes in 1637, but it remained for Lieberkuhn, 100 years later, to apply it in a convenient and serviceable form. The reflector is known as a "Lieberkuhn" and is used at the present day. Mr. Rousselet also described two old microscopes lent for exhibition by Mr. T. H. Court. The first, a small portable simple microscope signed E. Cuff, was probably made about 1750. The pillar is inclinable and is mounted excentrically upon a thin oval brass plate upon which it can be rotated to give stability to the instrument in different positions. It has a fine adjustment of the John M[illegible] to the lens-holder. There is a concave mirror, which with the lens-holder, stage and oval foot are hinged so that they can be folded up. It seems probable that this instrument may have been the parent model of Ellis's Aquatic Microscope. The second microscope was by Watkins and Smith, who were in partnership from 1765 to 1775, which circumstance fixes the date of the instrument. The general features are similar to those of a microscope made entirely of silver by Francois Watkins that was exhibited at a Meeting of the Society in November, 1907, the date of which was about 1754. Watkins at this date was "Optician to their Royal Highnesses Prince and Princess of Wales, at Sir Isaac Newton's Head, Charing Cross." This latter microscope was [illegible] rigidity, but the model now exhibited was more [illegible] made and was free from vibration. The fine adjustment of the silver microscope was absent and a strong [illegible] pinion coarse adjustment applied to the stage was substituted. There are seven powers mounted on a disc between two brass plates. The instrument is inclinable and can be used as a simple or with a body and eye-piece, as a compound microscope. The mirror is double, plane and concave.

Mr. Conrad Beck exhibited the "Focostat Lens" described below.

Mr. E. J. Sheppard exhibited two slides. The first was a vertical section through the four upper [illegible] of a kitten about six days before birth, the section passed through nearly the centre [illegible] in equal [illegible] [illegible]

Mr. Sheppard [illegible] The second [illegible] the [illegible] [illegible]

Mr. C. F. Rousselet [illegible] [illegible] four Rotifers from [illegible] Devil's [illegible] [illegible] water [illegible] South Dakota, the point [illegible] that of [illegible] fresh water [illegible] One, *Pedalion fennicum* [illegible] found in Finland, and the two [illegible] species, *Brachionus* [illegible]*atiosus*, the third *Brachionus satanicus* Rousselet, known only from this locality, [illegible] the fourth was *Asplanchna* [illegible]*strii* Dodav, E. P., showing [illegible] dimorphism in the female.

Mr. F. Enock gave a lecture on "Fairy Flies and their Host." His interest in these minute flies (Mymaridae) was excited by seeing one that was exhibited by the late Frederick Fitch at a Conversazione given by the Society in 1875 or 1876. At that time the only illustration known was that of a very minute insect drawn in 1797 by Dr. Grew of the Royal Society, and published in the Linnean Society's Transactions. Up to four years ago Mr. Enock had worked on the subject alone. He was then joined by Mr. Chas. Waterhouse, of the Natural History Museum. The interesting fact was that the eggs of the Mymaridae are deposited in the eggs of destructive flies. The lecture was illustrated by many beautiful slides prepared by Mr. Enock, including a series of photomicrographs illustrating the life history of the fly from the time its egg was deposited in its host.

THE NEW FOCOSTAT LENS. The Focostat lens is the invention of Mr. E. H. Hiscott, a member of the Royal Microscopical Society, who devised it for his own use in the field. Those who know the difficulty of dissecting a flower under a high power lens will realise the great advantage of this contrivance. Even if the flower can be held by some means while the lens occupies one hand and a needle or scalpel the other, the slightest motion puts the lens out of focus.

FIGURE 226.

Hiscott's "Focostat Lens."

In the invention under consideration (see Figure 226) the lens is carried on the needle itself. It is focused once for all on the point of the instrument and follows every movement. The lens has a magnifying power of about seven diameters. It can be slid along the handle of the knife or needle and adjusted to the angle at which the observer is in the habit of holding his hand. It [illegible] to be most useful in zoological and botanical dissections and for fine drawings with a mapping pen, while [illegible] other uses will suggest themselves.

Messrs. R. & J. Beck, of 68, Cornhill, are putting the Focostat lens on the market together with dissecting knives and needles, mapping pens, and retouching pencils with special handles on which the Focostat is interchangeable.

Mr. Hiscott is greatly to be congratulated upon his extremely useful invention.

THE PSEUDOPODIA OF DIATOMS. Several observers, noticeably Mr. Grenfell and Professor Van Heurck, have discovered the appearance of projections from diatoms particularly in the genus *Coscinodiscus*, but it has been argued successfully up to the present that they are not parts of the diatom itself and are possibly parasites. At the meeting of the Royal Microscopical Society, held on March

20th, Mr. J. D. S[illegible] [illegible] trated the presence of what he called pseudopodia [illegible] Co[illegible]*nodiscus helioides* [illegible] by means of powerf[illegible] [illegible]ation and a black background. In his paper on the life [illegible] of the diatom which was sent to him alive by Mr. E[illegible] Sle[illegible]d, of Bournemouth, Mr. Siddall described his obse[illegible] of the movements of the *Coscino-discus* by means [illegible] filaments of protoplasm, which differ from the pseudop[illegible] of the Rhizopoda in that no circulation of the protopl[illegible] made out. It was the general opinion of t[illegible] present th[illegible] Mr. Siddall had made out a good case, and he showed not only living specimens but others mounted in a mixture of [illegible] in sea water. There are more than forty of the pseudopodia, and the diatom is held up from the surface on which it is resting by means of them as it, as Mr. Siddall says, it was walking on stilts.

CORRECTION. In the note "An attractive 'Common object,'" pages 153-4 "KNOWLEDGE" for April, instead of as at present, the last sentence should read: "The figure was drawn from a specimen treated in this way; the *paraphyses* and *asci* with contained spores $\times$ 265 and the separate spores B $\times$ 445.

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

MARKED BIRDS RECOVERED.—The current number (April) of *British Birds* contains (pages 312-318) a number of further returns, from which the following are taken, viz.:

	Marked	Recovered.
Cormorant (*Phalacrocorax carbo*)	Scilly Isles, 22nd May, 1911 ...	Finistère, France, 26th December, 1911
Lapwings (*Vanellus vulgaris*), two birds ...	Stirlingshire, 5th June, 1911 ...	Queen's Co., 24th December, 1911 and Co. Clare, 5th February, 1912
" " "	Peeblesshire, 24th May, 1911 ...	Vendée, France, 30th January, 1912
Black-headed Gull (*Larus ridibundus*) ...	Yorkshire, 1st July, 1911 ...	Flores, Azores, 11th February, 1912
" " " " ...	Schleswig, 24th June, 1911 ...	Yorkshire, 15th January, 1912
" " " " ...	Rossitten, 18th July, 1911 ...	Barbados, W. Indies, November, 1911

The editor, remarking on the Azores and Barbados records of the last-named species, says that it is said to be a common visitor to the Azores, and must come from Europe. He conjectures that, that being so, the Barbados bird probably reached there by natural means and may have been tempted far out of its normal course by following a ship.

FIRST RECORD OF THE HOOPOE IN ENGLAND. Mr. W. H. Mullens has recently pointed out that although the credit of including this bird (*Upupa epops*) in the British list is generally attributed to Christopher Merrett (1666), it of right belongs to an earlier writer. Thomas Muffett, in his "Healths Improvement," published in 1655, says that although "Houpes were not thought . . . to be found in England, yet I saw Mr. Serjeant Goodrons kill of them in Charingdon Park." (*British Birds* for March, 1912, Volume V., pages 276 and 279).

SALE OF THE EGGS OF THE GREAT AUK. On Wednesday, April 17th, two eggs of the Great Auk were sold at Stevens's. Neither of them was a particularly good specimen, and the prices realised were not, therefore, very high. There is rather a romantic story attached to the first, as it is one of the two which were bought by a boy at a sale in Kent in 1894 for 36s., and which within a month brought him in something more than £400. We learn from Mr. Thomas Parkin's paper on "The Great Auk," which is noticed on page 203, that this egg was sold on April 24th, 1894, to Mr. Henry Munt for £183 15s., and on June 20th, 1900, Mr. James Gardner bought it for the late Sir Greville Smyth for £180. This time it changed hands for one hundred and fifty guineas. The other egg, which fetched ten guineas less, was purchased many years ago with [illegible] number of sea bird [illegible] by the late Sir Greville Smyth, but nothing is known of its previous history. Both these [illegible] were knocked down to Mr. Rowland Ward. After wards [illegible] number of painted models of celebrated eggs, from the collection of Mr. E. Bidwell, were sold, and fetched prices varying from £2 5s. to £3 10s.

THE DRESSER COLLECTIONS. The University of Manchester has this winter had transferred to its Museum the very fine and extensive collection of eggs of Palaearctic birds made by Mr. H. E. Dresser, and also the library of books on ornithology and oology. The same Museum received the Dresser collection of birds more than twelve years ago, and is thus thoroughly equipped with the most authentic material for the study of European and eastern Palaearctic birds. Pains-taking research, continued over a long series of years, was taken in making the collections and only carefully authenticated specimens have been admitted, and most of them have a full history. The great English ornithologist who made the collections will be commemorated by these, as, along with the library, they are being kept together, and named the "Dresser Collection." This will be restricted to Palaearctic ornithology and oölogy, the field of Mr. Dresser's life-long and authoritative work.

EXTREMES OF SIZE IN BIRDS.—In *The American Naturalist* for March, 1912, Dr. A. W. Henn writes on this subject with reference to vertebrates generally. Of birds he says that the smallest is a Humming Bird (*Calypte helenae*) from Cuba, total length two and a-quarter inches (fifty-seven millimetres), but that several other species of Hummers, such as the Jamaican *Melisuga minima*, which measures two and nine-sixteenth inches (sixty-five millimetres) are only slightly larger. No mention is made by Dr. Henn of the biggest bird, but this amongst living species is the Ostrich which, however, is greatly exceeded by the extinct New Zealand Moa (*Dinornis*). The most massively built of all birds was probably the extinct Patagonian Seriema or Cariama (*Phororhachos*), with a skull approaching that of a horse in size; but in massiveness of limb this species is exceeded by some of the great birds of the genus *Aepyornis* from Madagascar, the remains of which are conjectured to have given rise to the legend of the Roc. It is not easy to say which is the largest flying bird, as wing expanse scarcely affords a true criterion, but the usual claimants for this are the Giant Albatross (*Diomedea exulans*) and the Chilian and Californian Condors (*The Field*, April 13th, 1912, page 744). Amongst living British birds the smallest in size is the Gold-crested Wren (*Regulus cristatus*), about three and a-half inches in length, and the largest is the Whooper or Wild Swan (*Cygnus musicus*), measuring five feet. Between this and the next biggest and better known birds is a considerable difference, these being the Golden Eagle, averaging thirty-three to thirty-five inches, the Gannet, thirty-three inches, and the Cormorant, thirty-two inches in length respectively.

BIRDS AND GENETICS. In the course of lectures this winter by Mr. W. Bateson at the Royal Institution, London, on "Studies in Genetics," birds, along with other animals, were cited to illustrate our ignorance of the factors which control variations in animals. What (asked Mr. Bateson) was the cause of the difference between the Black Crow and the

Hooded Crow, between each of which there was an intermediate form, possibly a hybrid? If a line were drawn from Glasgow to the Adriatic Sea the Black Crow would be found on the east of it and the Hooded Crow on the west. No answer had yet been found for their differentiation. More puzzling still was that birds of exactly the same species were found in the northern half of India and not sighted again till Ceylon was reached, a slightly different species separating the two. The variants never passed over the border line, and yet were within "crowing distance" of each other. The Tree Sparrow and the House Sparrow differed in their markings, and the male of one kind could be distinguished from the female of the other kind only by dissection. In America there were to be found male birds which moulted to the colour of the female. These differences and distinctions still await reasoned explanations.

PHOTOGRAPHY.

By Edgar Senior.

RADIO-ACTIVE BODIES.—Interesting as the results brought about by the action of ultra-violet rays are, especially in the light of their practical bearing upon everyday work, there are other instances of photographic effects resulting from invisible radiations, which may claim our attention equally well. First of importance among these stands the discovery made by M. Henri Becquerel in 1896, that the double sulphate of uranium and potassium, and also the metal uranium itself, emitted rays that were capable of forming impressions upon photographic plates in total darkness. It was at first thought that the cause might be due to phosphorescence, as uranic salts possess this property when exposed to ultra-violet light (although only for a very limited period) but as urarous salts "which are non-phosphorescent" were found to be equally active the above explanation became untenable. That the action was not due to stored up energy from previous exposure to sunlight was proved by the fact that crystals deposited from solutions in darkness possessed exactly the same properties as those previously experimented with, and which had been exposed to light. Further experiments pointing to the absence of evidence of either reflection, refraction or polarization, went to show that the effects could not be due to ether waves of the nature of light. The posing problem was, however, finally solved, when it was discovered that those rays which act photographically can be deflected by a magnet, and that their behaviour in all respects was similar to cathode rays, which consist of streams of negatively-charged particles projected with great velocity. In honour of the discoverer these rays have been called Becquerel rays, but the term radio-active is now generally applied to such bodies which belong to a class of substances of which uranium, thorium, radium and their compounds form part, and which possess the property of spontaneously emitting radiations which are capable of passing through substances opaque to ordinary light, such as metal plates, and the still further characteristic of being able to impress a photographic plate in the dark, and of discharging electrified bodies. It is also found that radium, which is a strongly radio-active body, is able to cause marked fluorescence and phosphorescence in some bodies placed near it. The remarkable property of radio-active bodies is their power of being able to continuously radiate energy, and at a constant rate, without "so far as is known" any external exciting cause. As already stated thorium belongs to this class, and in Figure 227 is shown a portion of an incandescent gas mantle the photograph of which was taken in total darkness by means of the radiations given off by the thorium, which was present in small quantity in the mantle. The photographic plate from which the print was made was enclosed in an orange paper envelope, the mantle was laid upon this, and the whole enclosed in a tin box which was placed away in a cupboard for three weeks. The image was then developed, with the result shown.

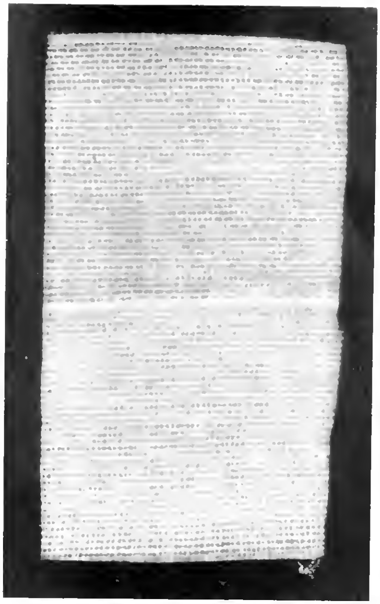


Figure 227. Part of an incandescent gas mantle, photographed in total darkness.

THE EFFECTS OF DAMP ON PHOTOGRAPHS.—It has lately been found that a good many photographs and mounts are affected with mildew, although kept under the same conditions under which they had previously shown no signs of any such trouble. The cause is no doubt due to the excessive amount of wet weather experienced some time back. The form of the fungus (for such it is) is of the nature of that which produces common mould and is known by the name of *Penicillium glaucum*. This plant may be found on the surface of jellies and preserves, and consists of a mass of filaments serving as its base, and from the surface of which rise up thin stems bearing at their extremity a number of minute cells which are the spores or reproduction organs. These plant-like threads thrive in damp atmospheres of cellars or rooms generally, and gelatine forms a good medium for their propagation. They form beautiful

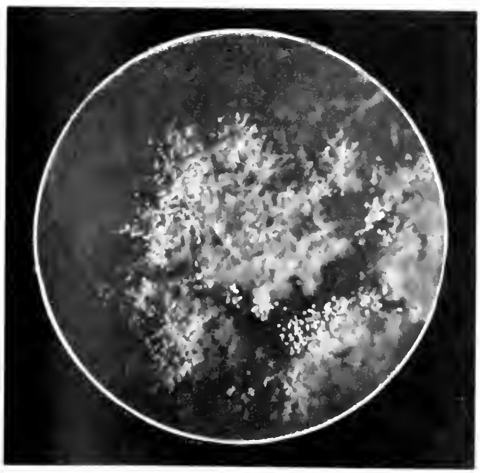


Figure 228. A Fungus (*Penicillium glaucum*) on a gelatine photographic film, magnified.

object for the [illegible] especially when illuminated by reflected light, but are hardly satisfactory as an addition to the photograph, to [illegible] of the effect they may have on the print itself. Some idea of their appearance may be gained from the illustration [illegible], which is a photomicrograph taken by reflected [illegible]. The little white dots are the spores. The want of definition in parts is due to differences of distance of the image planes, for although a narrow angle objective was employed in order to obtain depth of definition, the distances apart of different parts of the object were too great. When the fungus was removed from the print by brushing or careful rubbing with a piece of cotton wool, the picture was in many cases found to be uninjured; in others spots remained. Far more serious is that effect of damp which causes a fading of the print generally, brought about most probably by decomposition products of the mountant itself in many cases, aided by small quantities of the fixing agent remaining in the print. Obviously the best way of protecting prints from the troubles arising from mildew is to keep them as far as possible in a dry and pure atmosphere, as the fungus of which we have been writing flourishes in a damp and unwholesome one.

EXPOSURE TABLE FOR MAY.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and lens aperture F/16.

Day of the Month	Condition of the Light	Time of Day: 11 a.m. to 1 p.m.	10 and 2	3 p.m.	Remarks
May 1st	Bright	08 sec.	1 sec.	12 sec.	If the subject be a general open landscape take half the exposures given here.
,,	Dull	2 ,,	21 ,,	24 ,,	
May 15th	Bright	07 sec.	09 sec.	1 sec.	
,, ,,	Dull	18 ,,	19 ,,	2 ,,	
May 31st	Bright	06 sec.	08 sec.	1 sec.	
,, ,,	Dull	16 ,,	18 ,,	2 ,,	

PHYSICS.

By Alfred C. G. Egerton, B.Sc.

GLOW IN HYDROGEN.—Hertz had observed a glow in hydrogen after the passage of an electric discharge from a Leyden jar, the hydrogen being at a pressure of one hundred millimetres of mercury. Professor Strutt, in continuation of his work on the glow produced by electric discharges in various gases, which has led to such important results in the case of nitrogen, has investigated this glow in hydrogen. He finds that it is due probably to traces of sulphuretted hydrogen, which are decomposed by the discharge, and subsequently the sulphur and hydrogen re-combine and in doing so emit a bluish light.

THALLIUM FLAME.—Dr. Lowry has described an ingenious method of obtaining the monochromatic green thallium flame, for use in polarimetric measurements. Thallium chloride is heated in a silica bulb, which is connected by a metal tube to the tube of a Bunsen burner and passes up within it, terminating in a vertical jet. A current of oxygen passes over the heated thallium chloride and carries the vapour over into the flame, giving a steady lasting colour to it.

G. E. Gibson has heated metallic thallium to 1300° C. in an evacuated quartz tube. The vapour emits the green line strongly, and it has been shown that this is a true temperature radiation and not merely a luminescence effect. The light from the tube was focussed on the slit of a spectroscope; after the introduction of the cold tube containing the thallium, the dark thallium line crosses the continuous spectrum of the radiation from the furnace, but this gets fainter and disappears as the temperature of the thallium vapour reaches that of the furnace. In three minutes the black absorption line has disappeared altogether with the temperature of the furnace standing at 1450°, and if the tube is suddenly removed from the furnace, the thallium line appears bright against a dark background. It is not easy to obtain direct evidence of the production of bright line spectra by the effect of temperature alone, but this experiment shows the effect very beautifully. Professor Wood has described an experiment, already mentioned in these columns, in which iodine is dropped into a hot quartz bulb, the vapour of the iodine giving out a reddish light and making the quartz bulb appear red hot.

The nature of the light emitted by a flame depends on the nature of the flame itself. A. Harnack has investigated the spectra of various metals in the oxyhydrogen flame, and has compared them with the spectra obtained in the hydrogen-chlorine flame, which has a temperature of 2300°. Only chloride bands are common to both flames; thus the copper chloride bands in the oxyhydrogen flame would correspond to the copper bands in the hydrogen-chlorine flame. The hydrogen-chlorine flame spectra of the metals gives rise to comparatively few lines. The chloride band spectra are more fully developed in the hydrogen-chlorine flame than in the oxyhydrogen flame in which the chlorides of the metals are burnt.

RADIOACTIVITY.—There is no well-established case where radioactivity is caused by artificial means. In speaking of flames we may refer to the work of Carter, published in *The Philosophical Magazine* of November last in this connection. Searching tests have been made to find whether any β rays are emitted when large changes of energy occur during the combustion of substances giving rise to high temperature flames, but no positive result has been obtained. Special precautions had to be taken during these experiments to prevent effects of temperature on the electroscope used for detecting the presence of the rays. In the flame itself enormous ionisation is occurring—and no doubt electrons are set free within the flame, but these are still part of the processes going on within the flame, and no electrons are projected out with great velocity, and lost to the body projecting them, as in radioactive processes. The author investigated the radiation from the electric arc, the spark, and the oxyacetylene flame to search for an effect, but none was obtained.

Mention may be made here of a negative result obtained by Dr. J. Vincent; he investigated whether the period of radioactive change could be altered in any way by the application of powerful electric fields. No change of any kind was observed. The spontaneous processes occurring within the atom giving rise to radioactivity are still out of human control, but every week adds knowledge to the nature of these processes. Professor Rutherford's, and his collaborators', work on the counting of the α particles emitted from radioactive substances by scintillations produced on zinc sulphide screens, and the scattering of α and β particles by various substances is giving rise to further knowledge of the internal structure of the atom.

The α rays from different substances are characterised by their range or the average distance through which they travel in air at the standard temperature and pressure—0° C. and seven hundred and sixty millimetres. Geiger and Nuttall have investigated the ranges of α particles from uranium and thorium and have found that they are proportional to the transformation constants—the constants of the time of change from the one radioactive substance into its successor—and since no α ray products are known of very short range the explanation is probably to be sought here, for the life of a substance emitting α rays of one centimetre range would be so long that its period of change would be very slow and its activity would escape detection.

FOG.—Dr. Aitken has shown that the sun causes the production of fog when a light wind brings an impure and damp air into the neighbourhood; while when the wind comes from a pure direction, the sun causes no fog to appear. He has come to the conclusion that the fogs are due to the action of the sun on the sulphur products in the air produced by the combustion of coal, and also to the sunshine forming hydrogen peroxide in the air. In this way particles are formed which can condense water vapour in air unsaturated with moisture.

The melting of an iceberg is accompanied—especially in calm weather—with the production of fog, because the air in the neighbourhood soon becomes super-saturated with moisture, while the low temperature causes deposition of this moisture. For this reason, and also owing to the peculiar cloud-like aspect of an iceberg at night, the iceberg is not easily visible. The danger is increased by the fact that the extent of the iceberg may be far greater under water than it appears to be above: the action of the waves help to cause a shelving away of the berg near the surface of the water. The actual volume of the ice above water always has a fixed ratio to that below, about as one is to eight. The detection of icebergs becomes a matter of great importance to shipping—as has been so deplorably made manifest recently by the disaster to the "Titanic." The method by means of which the whereabouts of an iceberg might be established cannot be numerous, for the reason that the ice is much the same substance as water: one could suggest, perhaps, a few possible methods of detection—temperature of the water, or saltness of the water in the neighbourhood of the iceberg. However, in a big pack or icefield, the alteration of such properties of the sea water would not be sufficiently great to be of practical value. It would appear more practical to provide every ship with some form of search-light which could be made to automatically pass a very intense beam of yellow light across the course of the ship from side to side. The yellower the light the more fog-resisting the beam. This suggestion would seem the most practical method of combating a danger which can have such appalling consequences. The lighthouse is at any rate some use in a fog.

EMISSION OF ELECTRONS DURING CHEMICAL CHANGE. Lavoisier's principle that "matter is indestructible" and that "during a chemical change there is no loss or gain of matter" has been proved by Landolt to hold, so far as the most accurate balance can settle the question. But since heat is often evolved during such a change and since the force of chemical affinity appears to be of an electrical nature, it is quite possible that the energy changes entail loss of electrons—which would be quite undetectable by the change in weight of the reacting substances. Professor Haber has recently made experiments on amalgams of sodium and the other alkali metals and finds that in an exhausted space containing small quantities of reacting gases, such as bromine or phosgene gas, the metal acquires a positive charge and negatively charged electrons are set free. Similar experiments with quinine salts showed that they absorb water and in doing so tend, owing to discharge of negative electrons, to ionise the air. Gases, evolved by the action of acids on metals, Sir J. J. Thomson showed to be ionised and his interesting results were published in a book entitled the "Discharge of Electricity through Gases." Such experiments lead to the questions "To what extent is the atom of an element capable of undergoing change in electrical structure before it ceases to behave in its own distinct manner?" and "To what extent is the atomic mass of an element an invariable quantity?" Does the "atomic mass vary with the temperature?"

EXPLOSIONS.—An interesting study of the radiation during explosions forming carbon dioxide and water vapour has been recently published in the October *Philosophical Transactions of the Royal Society*, by W. T. David. The results appear to show that when an explosion occurs the vibratory energy is a maximum before the maximum pressure is attained and, therefore, before the mixture attains the maximum temperature. Hence it is probable that a considerable part of the energy of combination goes to set up internal vibrations of the carbon dioxide and steam molecules: part of this energy is lost as radiation and part is transformed into rotational energy and translational energy, the latter causing increase of pressure of the gases. The work of Professor Dixon and also of Professor Hopkinson, on the propagation of explosions is highly interesting and should be consulted by those who wish to follow up the matter.

ZOOLOGY.

By Professor J. Arthur Thomson, M.A.

INTELLIGENCE OF FISHES. There are not many precise data in regard to the intelligence of fishes. Some observers say they can be trained a little; others, like Edinger, deny them even memory. It seems that the brain, of bony fishes in particular, remains at a low grade. M. Oxner has recently made some interesting observations at the Oceanographical Museum at Monaco with a fish called *Coris julis*. When he disguised the hook perfectly he caught the same fish as often as he pleased. But that only proved that the disguise was perfect and that the fish was appetised.

In another set of experiments he used an equally well hidden hook, but placed a piece of red paper on the gut-line a couple of inches above it. For the first week the fish (an inexperienced one, of course) remained indifferent: on the eighth, ninth, tenth and eleventh days it took the bait; on the twelfth day it refused the bait till the red paper was removed; on the thirteenth, fourteenth and fifteenth days it refused the bait with the red paper, though it examined it carefully: on the sixteenth day and on the following six days it began by snapping at the red paper, and then turning to the hook bit off the bait in small scraps, without any hurry, and with a thousand precautions.

It looks as if an association was here established between the pain of being hooked and the red paper, and as if the latter became a warning advertisement, inhibiting the instinctive attraction to swallow the bait, literally putting a drag on the animal's movements. Gradually, however, the fish regained liberty of action, it disregarded the taboo, it very deliberately experimented with the bait, it succeeded, and we say that it "understood." Apprendre, M. Oxner says, n'est que la série successive des essais réussis.

RESOURCES OF THE SEA.—With the great resources of the sea, such as fishes, whales, seals, turtles and crustaceans everyone is familiar, but the miscellaneous minor treasures are less appreciated. It is interesting, therefore, to take a concrete case, and we may refer to Alvin Seale's account of the miscellaneous marine products of the Philippine Islands. There are the trepangs or sea-cucumbers, a staple food of all Oriental people; Sharks' fins are dried, cured, and exported to China as a basis for soup; there is the window-shell (*Placuna placenta*) the right valve of which is used intact instead of glass in most of the buildings in the city of Manila; there are several Gasteropods, such as *Trochus niloticus* and *Turbo marmoratus*, whose shells are used for button-making; there are various corals (including apparently the precious coral) useful for decorative purposes; the black antipatharian is used for making canes; there are several edible seaweeds; and there are sea-snakes whose skins make beautiful leather.

PURIFICATION OF OYSTERS.—Fabre-Domergue continues his important experiments on the purification of oysters. He has tried keeping them in filtered artificial sea-water, introducing a sand filter into a closed circulation through a series of tanks. He has obtained excellent results not only as regards purification, but as regards the vitality and flavour of the oysters.

EXPERIMENTAL REDUCTION OF WINGS.—J. Dewitz returns to some very interesting experiments which he made a dozen years ago on wasps (*Polistes*). He placed the nests for forty-eight hours in a refrigerator and found that this had the result of hindering the development of the wings. Similarly, with the pupae of flies (*Calliphora*), exposure to cold resulted in defective wings. Extending these experiments, Dewitz finds that chrysalids with shortened wings result when the caterpillars of *Porthesia chrysorrhoea*, just about to undergo metamorphosis, are placed in an atmosphere containing hydrocyanic acid. It seems that a ferment (tyrosinase), which occurs diffusely in the larva, is localised in the wings of the pupa, and the author suggests that the artificial conditions noted above act prejudicially on the ferment. Perhaps the [illegible] in [illegible] [illegible] [illegible]

MASSES OF WATER-WORMS. Professor George H. [illegible] case of mechanical [illegible] caused by [illegible] A [illegible] six inches by four inches in [illegible] completely blocked for a distance of [illegible] masses of minute Tubificid worm, which [illegible] Mr. R. Southern as *Limnodrilus udekemianus* [illegible] worm can live in water or in mud, and [illegible] forming large tangled masses, which [illegible] and can offer great resistance to strain.

DISCHARGE OF CUVIERIAN ORGANS. Mr. G. R. Mines [illegible] studied the mode of discharge of the Cuvierian organs of *Holothuria nigra*. They are white conical bodies, expelled [illegible] when the sea-cucumber is irritated. They remain attached by their bases to the animal, but elongate into long sticky tubes which are disconnected. Undischarged Cuvierian organs removed from the Holothurian can be made to elongate by injecting them with sea water or other fluid. The natural discharge is always preceded and accompanied by a rise in the pressure within the body. It seems, then, that the elongation is due to internal fluid pressure, and not to any intrinsic activity of the tubes.

TENACITY OF LIFE IN CATERPILLARS. While the larvae of some insects, such as fleas, are delicate and readily killed, it is very much the reverse with others. L. Bordas finds a good example in the Potato Caterpillar (*Phtorimaea operculella*), which is notably difficult to kill. He notes, for instance, that immersion in alcohol (70°) for six to eight hours left them able to contract the body, and to move the head and limbs and mandibles. The power of resistance is referred to the structure of the respiratory system (stigmata and tracheae), but one would like to have more precise explanation.

POLYDACTYLY. In reporting two instances of supernumerary thumbs, which are not so common as supernumerary little fingers, Dr. J. D. Fiddes refers to the theory of aetiology of this peculiar condition. The case may be stated thus: (1) Where the extra thumb is a sixth digit there is no use at all in dragging in the idea of a reversion to a long-lost ancestor with more than five digits. There is no evidence of there ever having been any creature [illegible] more than five digits. (2) [illegible] polydactyly has run [illegible] generation after generation. A tendency to a duplicated [illegible] little finger [illegible] hereditary. In [illegible] case the condition [illegible] symmetrical, often involving all the four extremities, and often associated with other inborn peculiarities. (3) A case of polydactyly cropping up without any hereditary [illegible] but [illegible] it may be due to a germinal variation similar to [illegible] started the hereditary series already referred to. (4) Finally, the polydactyly may be modificational rather than variational. That is to say it may be due to "a developmental accident"—to an abnormal amniotic band pressing upon the digital bud and splitting it. Such cases of "schistodactyly" are asymmetrical.

LENGTH OF ALIMENTARY CANAL AND LENGTH OF BODY. A. Magnan has made careful measurements of the length of the food canal in thirty species of mammals (two hundred and eighty specimens), and finds that its ratio to the length of the body is least in the carnivorous forms, greatest in the vegetarians, and intermediate in those that may be called omnivorous. The same general statement holds true of birds, and is to be interpreted as a physiological adaptation to the digestibility of the various types of food. It applies not merely to the length of the food canal, but to its internal surface, though the patient measurer has not yet taken the villi into account.

HYBRIDISING SEA-URCHINS.—Professor E. W. MacBride, working at the Marine Biological Station at Millport on the Clyde, has succeeded in fertilising the eggs of the common heart-urchin (*Echinocardium cordatum*) with the sperms of *Echinus esculentus* and in rearing the hybrid larvae for eight or nine days. Previous workers on similar lines have, in most cases, found that the hybrid larvae of sea-urchins were of the maternal type, but MacBride finds in his case that the larvae show paternal characters as well. The case is of great interest on this account and also because the two genera are so far apart. The author points out that *Echinus* and *Echinocardium* have been distinct since the beginning of the Secondary epoch, and that their common ancestor could not have lived later than a period which a moderate estimate would place at twenty million years ago; yet the germ-cells of the two types will commingle so as to produce a hybrid in which both paternal and maternal characters are represented.

STONYHURST COLLEGE OBSERVATORY.

By FRANK C. DENNETT.

The report of this busy observatory for 1911, by Rev. W. Sidgreaves, S.J., F.R.A.S., its Director, is just to hand. The year's mean barometric pressure was only ·053 inch above the average of the last sixty-four years. Every monthly mean, excepting November and December, was above its average, January showing the highest and December the lowest of the year. January had a rainfall nearly two and a half inches short of its average, whilst December was over two and a half inches in excess. The latter was the wettest month of the year, rain falling on twenty-seven days, but it was warm, the temperature being 1°·2 above its average. February was another very wet month being 2·68 inches in excess of the average. July had a rainfall over three inches below its average, receiving less than a quarter of its usual supply. July was also remarkable in having bright sunshine for eighty-two hours in excess of the monthly average, and sixteen hours above all previous records. The mean temperature of August was half a degree higher than that of July, and was the highest on record for the month, and 4°·7 above the average. The mean temperature of the year, 48°·6 is 1°·7 above the average. April 19th had a wind velocity of fifty-three miles per hour, a record for April. The decrease in the daily spot area upon the Sun, and the mean daily range of the magnetic declination (in minutes of the arc), is well shown, as compared with previous years.

Year	1906	1907	1908	1909	1910	1911
Spot area	4·8	5·8	4·6	3·8	1·8	0·3
Declination range ...	13·9	14·7	14·1	13·5	14·5	12·6

The unit of the spot area is equal to one-fivethousandth part of the visible disc.

The monthly means indicate the solar minimum in December. But this may perhaps be a little premature.—F.C.D. The magnetic minimum resting on daily measures, distinctly points to a date later than December, 1911. Of the eight comets of the year, three were under as constant observation as the weather would permit, sixteen photographs being taken of that of Brooks.

THE PARTIAL SOLAR ECLIPSE, APRIL 17th, 1912.

By E. W. BARLOW, F.R.A.S.

THIS phenomenon was observed at Bournemouth, where the extent of obscuration was between 91½ per cent. and 92 per cent., under excellent conditions, the sky being throughout absolutely cloudless and the definition good.

I obtained with my usual arrangement (4-inch refracting telescope with camera and yellow colour filters attached) a fine series of twenty-four negatives of all phases of the eclipse. The accompanying one was taken at 12·5 p.m. Greenwich time. I do not know exactly when the maximum obscuration occurred here, but this photograph was secured at not more than two minutes' interval of time from mid-eclipse.

It is enlarged, the original image being about 2¼ inches in diameter.

The solar disc was absolutely free from markings of any kind, spots or faculae.

The irregularity of the lunar limb is well shown: there are two distinct peaks visible on this (and several other of the negatives) about one-third of the way round the arc of the lunar limb from the right hand (west) side.

The diminution of the sun's light was very marked indeed and the eclipse proved a noteworthy spectacle. Indoors at mid-eclipse a heavy gloom like that of a thunderstorm pervaded. Outside the sunlight was very feeble and somewhat ruddy, the sky a deep leaden blue and all colour much toned down as if shaded with black. At 11.45 a.m., about twenty-five minutes before mid-eclipse, a small cumulus cloud which appeared on the N.W. horizon had a distinct coppery shade.

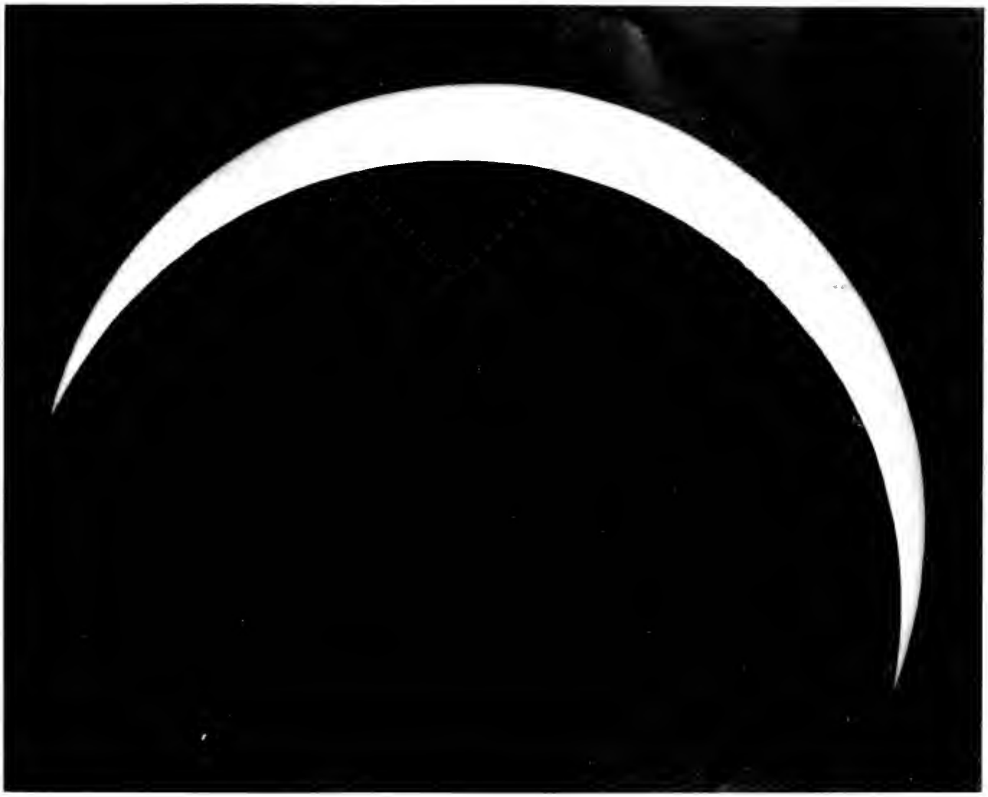


Figure 229. Solar Eclipse. Greatest phase, [illegible]

About eight minutes after mid-eclipse, on disconnecting the camera and substituting a Thorp polarising solar diagonal, I clearly perceived, for some considerable distance beyond each cusp, the portion of the lunar limb outside the sun's disc—in other words, the projection of the moon on the corona. This was also observed, to a less extent, with a three-inch refractor, ordinary solar diagonal and green cap, a few minutes later.

The temperature in the sun on the grass fell from 91° F. at the beginning to 55° at 12.14 p.m., about seven minutes after mid-eclipse, and rose to 90° by 1.30 p.m., the end of the eclipse—a drop of 36°. These observations were made with an ordinary thermometer, the bulb of which was surrounded by metal bars to hold it in place. The fall recorded is very nearly equal to that obtained with the blackened bulb thermometer at Greenwich [illegible]. In the shade on the grass, a second thermometer stood at [illegible] F. at the beginning and end, and fell to 44° at 12.30 p.m. [illegible]

The very slight easterly wind, after veering to the south, dropped to a dead calm at mid-eclipse, returning afterwards to its former strength.

Birds were unaffected by the phenomenon, singing loudly at [illegible] that tulips in the sun, which were open prior to [illegible], closed right up before the mid-eclipse and were [illegible] to the end. Those in the shade were unaffected. [illegible] the interval between my photographs allowed, I kept a watch for other phenomena, shadow bands, and so on, but nothing was seen. A white sheet was spread on the ground for this purpose.

SOLAR DISTURBANCES DURING MARCH, 1912.

By FRANK C. DENNETT.

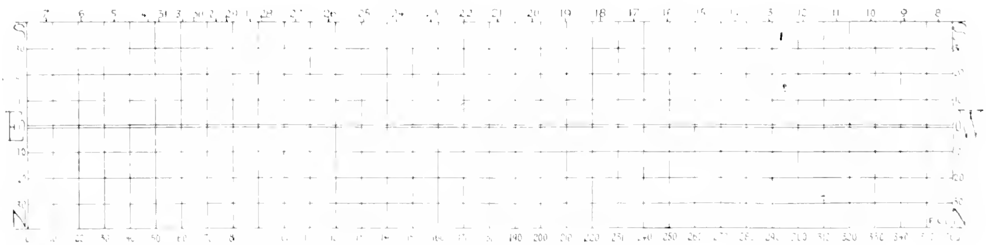
MARCH has a more interesting record than the two previous months. Only on twelve days has the disc been apparently quite free from disturbance, though on seven others only faculae were seen, but a spot group, the first this year, was visible on the remaining twelve. The longitude of the central meridian at noon on the 1st was 86°51'.

1. A bright faculic disturbance within the eastern limb, on the morning of March 7th, was seen to contain a spot about fifteen thousand miles in diameter, with a bright photospheric arm penetrating a long way from its north-eastern border. In the afternoon this was found to be the leader of a considerable group. The group was very active presenting constant change. On the 11th, a pore easily seen at 9.30 a.m., could not be found a few minutes later. At 2.30 p.m. the spectroscope showed considerable activity present. The axis of the group showed a decreasing angle with relation to the solar equator as the group progressed across the disc, and on the 18th only the leader remained visible, much decreased, amid a faculic disturbance, the latter being still visible next day. On the 9th, 10th and 13th, the inner edge of the penumbra was noted as being brightly fringed. It will be noticed that this group is in the same position as the little group No. 41 in the record for December, 1911.

A faculic disturbance was recorded near the south-western limb, on March 3rd, and so near longitude 140°. On the 5th, a similar area was seen near the same limb, and therefore near longitude 95°. On the 6th and 7th, a faculic district in longitude 310°, N. latitude 28°, was advancing from the north-eastern limb. On the 10th a small bright knot in longitude 180°, S. latitude 66°, was noted. On the 18th, a faculic disturbance was seen nearly in the same longitude as the spot group, but much farther south. On the 22nd, a bright knot was within the eastern limb, near longitude 90°. On the 24th, a faculic district was nearing the north-western limb, and on the 27th and 28th, a small facula was near the western limb, longitude 170°, S. latitude 7°. Two of these will be found marked on our chart.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, W. H. Izzard, and the writer.

DAY OF MARCH.



REVIEWS.

ARCHAEOLOGY.

The History of Fire-Making. By EDWARD BIDWELL. 24 pages. 48 illustrations. 9-in. × 5¾-in.

(O. E. Janson & Son. Price 1/- net.)

That the interest and value of a publication are by no means proportional to its size is shown by Mr. Bidwell's little book. For very many years Mr. Bidwell has collected and studied the various methods of obtaining fire, and in 1910 he showed a representative series of specimens and illustrative pictures in the science section of the Anglo-Japanese Exhibition. So few, however, of the catalogues, containing a description of these, were available that many of those who would have highly valued the synopsis of Mr. Bidwell's researches were unable to secure a copy. Now the difficulty is removed, for Mr. Bidwell has reprinted the pages from the catalogue, with the addition of some illustrations made from his specimens for Mr. Miller Christy. The frictional methods which at the present time are practically confined to native races first come in for attention, then casts of an iron pyrites nodule and a flint flake found in a British barrow by Canon Greenwell, as well as photographs of two nodules of iron pyrites used instead of flint and steel in a tinder box in Suffolk until about 1827. Passing over flints, steels, sulphur-tipped matches, tinder and tinder boxes, we come to the fire piston, burning glass, and the electrophorus. The early chemical methods, which include the first matches and ways of getting fire before these were produced, complete the series and are possibly the most interesting, generally speaking.

Arrangements for bringing a sulphur match or a taper into contact with semi-oxydized phosphorus and then with the air are apparently the earliest and go back to the end of the eighteenth century. The details of Lorentz's electro-pneumatic lamp were taken from the Patent Office records of 1807, and in this, hydrogen gas was ignited by means of an electric spark. Pyrophorus was finely-divided carbon which ignited upon exposure to the air. The instantaneous light box was introduced into England in 1812. In this, chlorate of potash matches were brought into contact with asbestos soaked in sulphuric acid. Dobereiner's hydrogen lamp depended upon the fact that spongy platinum becomes incandescent when gas is allowed to impinge upon it and lights the latter. The Promethian match, which was patented in 1828, contained a tube of sulphuric acid surrounded by a mixture of chlorate of potash and sugar. Walker, of Stockton-on-Tees, however, sold his first box of friction matches on April 7th, 1827. "Lucifers" were ignited by being drawn through folded sand paper. "Congreves," again, could be struck upon the box. Mr. Bidwell's catalogue describes a number of other forms which have played their part in the evolution of the match.

W. M. W.

ASTRONOMY.

The Science of the Stars.—By E. Walter Maunder. 95 pages. 6½-in. × 4½-in.

(T. C. & E. C. Jack. Price 6d. net.)

The author is well known to readers of "Knowledge," and has compressed a surprising amount of information into the short compass of ninety pages. The early chapters give a short summary of the matter given more fully in the author's other books, "The Astronomy of the Bible" and "Astronomy without a Telescope." There follows a carefully written chapter on "The Law of Gravitation." "Astronomical Measurements," leads us up from the primitive obelisk and dial to the invention of the telescope, and a few of the results of exact astronomy. There is then a physical chapter discussing the telescopic appearance and probable condition of the orbs of the solar system. The final chapter deals with the system of the stars, their distance, number, brightness and motions. It may be safely said that a beginner who has mastered this little book has laid a sound foundation of astronomical knowledge, and is in a better position to tackle larger and more technical treatises. We notice one little slip *re* Halley's Comet on page 36. Halley is stated to have identified his comet with those of 1378 and 1301. Halley in reality erroneously identified it with the comets of 1380 and 1305; the correct identifications with those of 1378 and 1301 were made subsequently by Laugier and Hind respectively.

A. C. D. C.

The A.B.C. Guide to Astronomy.—By Mrs. H. Periam Hawkins. 120 pages. 7¼-in. × 4¾-in.

(Simpkin, Marshall, Hamilton, Kent & Co. Price, paper covers, 1/6 net; cloth, 2/- net.)

This is a useful dictionary and glossary of astronomers and their work. The author's name has become familiar to us of late years from her attractive and handy little volumes.

It is difficult to avoid all inaccuracy in works covering so large a field as this; a few are noted in the hope that they may be corrected in a future edition, not as implying that the work as a whole is untrustworthy:—

Page 3.—Altazimuth: for "reversible transit circle," read, "transit circle that can be rotated about a vertical axis, so as to point in any direction."

Page 6.—M. E. M. Antoniadi is a *Greek* not a *Frenchman*.

Page 6.—Aquarids. The showers of May and July are given as both connected with Halley's Comet. Only the May one is connected with it.

Page 14.—Borelli should be Borrelly. He is French not Italian.

Page 24.—Dr. P. H. Cowell left Greenwich Observatory early in 1910, on his appointment as superintendent of *The Nautical Almanac*. Correction also needed page 68.

Page 52.—The great eruption of Krakatoa was in 1883; that of Mont Pelée (Martinique) in 1902.

Page 54.—The use of filar micrometers for stellar parallax is certainly older than the Lick Observatory.

Page 66.—It is the eccentricity of the Moon's orbit, far more than the evection, that causes the length of the "quarters" to differ. Also, their maximum range of difference is only one and a half days.

Page 67.—Moon's Variation. Instead of "The greatest impulse in speed is three days before Full Moon," read, "The greatest displacement due to the variation occurs three and a half days before each of the four quarters."

Page 76.—Professor Perrine has left Lick Observatory for Cordoba.

Page 91.—The date of photography of the spectrum of the reversing layer should be 1896 not 1876.

Page 102.—The Precession of the Equinoxes has nothing to do with the Sun's motion in space.

Page 108.—The comet of 1862, *not* Tuttle's Comet, is connected with the Perseid meteors.

Page 113.—Watson's minor planets were not found by photography.

A. C. D. C.

A Popular Introduction to Astronomy.—By Rev. A. C. Henderson. 135 pages. 7 plates. 7½-in. × 4¾-in.

(T. & J. Manson, Lerwick. Price 2/6 net.)

This is a chatty and discursive little work, dealing with a few selected questions rather than a systematic introduction to the whole science.

In the chapter on Biela's Comet it is stated that the comet itself collided with the Earth on November 27th, 1872; it would be more accurate to say the swarm of meteors associated with the comet encountered the Earth; the swarm must be much larger than the comet itself.

We notice some looseness in places in the explanations, thus a Total Eclipse of the Sun is said to take place when the Moon is in Perigee, implying that this is a necessary condition; it is in reality possible in summer for a Total Eclipse to occur when the Moon is at about its mean distance.

He seems hypercritical in objecting to phrases like "the Sun rises above the horizon"; they are perfectly legitimate if it be borne in mind that all our ideas of motion are relative.

Beginners in astronomy will, however, pick up a good deal of miscellaneous information from this book, including some points that are absent from the more conventional handbooks.

A. C. D. C.

The Great Star Map.—By Professor H. H. Turner, D.Sc., F.R.S. 159 pages. 1 illustration. 7½-in. × 5 in.

(John Murray. Price 2/6 net.)

There is no one more competent than Professor Turner to write an account of the inception, progress, and partial completion of the Great Astrographic Star Chart. He took part in several of the conferences that have been held in Paris to settle the details of the work, and both at Greenwich and Oxford he has been most active in pushing on the taking of the plates and their subsequent reduction, for which he devised an elegant and simple method, which has been very widely adopted. He commences by tracing the history of photography as applied to astronomy, which now goes back more than half a century, and quotes an interesting letter of George Bond's, written in 1857, describing the successful photography of all naked-eye stars, and anticipating that future improvements might extend this to the eleventh magnitude—a daring prediction in those days, but now falling far short of the truth. The invention of the dry plate was a great step in advance; it was far more sensitive than the wet collodion plate, and permitted long exposures, whereas the latter ceased to be sensitive when dry. The number of stars shown on photographs of the great comet of 1882 came as a revelation of the possibilities of the new method, a hint which was quickly taken advantage of by Sir David Gill, Dr. Common, the brothers Henry and others. Finally, a great conference was held at Paris, under the leadership of Admiral Mouchez. There were advocates of three different forms of telescopes, reflectors, refractors and doublets. The reasons for the choice of the middle form are given; the whole sky was divided among eighteen observatories, all using refractors thirteen and a-half inches in aperture, with eleven and a-quarter feet focus (1′ = 1mm.) Another interesting point touched on is the "reseau" of small squares on the plates, originally introduced to detect unequal shrinkage of the film, but retained as a great aid to measurement.

Star counting on the plates is next discussed, and the fact that the ratio of increase of number of stars per magnitude falls short of its theoretical value four. He inclines in the book to two explanations: (i) a solar cluster of our neighbours mean, the stars, with a spur or region out aside it, and a certain amount of "fog" in space reducing the light of the more distant stars. This idea of a spur or region is advocated in the book, though the author has subsequently receded somewhat from this position, considering that it indicates actual structural arrangement in the sidereal universe.

It is rather startling to find that we can actually test how the telescope was focussed by counting the numbers of stars in different regions on a large number of plates. It is usual to focus for a ring about midway between the centre and the edges, and if so, the star density on the plates is greatest in this ring.

The very practical detail of cost of taking and measuring the plates and publishing the results is dealt with, and the necessity for moderation in the number and accuracy of the measures is insisted on, if the completion of the project is not to be indefinitely delayed. Oxford and Greenwich have finished their portions, but many of the smaller observatories are a long way behind. As one of the main objects of the scheme is to complete the survey of the heavens in a reasonable time, and repeat it after a term of years, so as to find the proper motions of the stars, this delay, due to too ambitious ideals, is a serious matter.

Other interesting matters touched on are the Eros Campaign in 1900-01 for deducing the Sun's distance, and the discovery of Nova Geminorum, of 1903, on the Oxford plates. The whole book is written in a fluent and easy style, and should be read by all who desire to gain an insight into the great astrographic scheme, which is bound to loom very large when the history of the astronomy of our times comes to be written.

A. C. D. C.

BOTANY.

Plant Life on Land.—By F. O. BOWER, Sc.D., F.R.S. 172 pages. 27 figures. $6\frac{1}{2}$-in. × $4\frac{1}{4}$-in.

(Cambridge University Press. Price 1/- net.)

The title of this little book is practically a paraphrase of that of Professor Bower's recent great work—"The Origin of a Land Flora." The author has, however, made no attempt at producing a summary of the latter, but has presented a series of separate essays, which at first sight may appear to be connected by a somewhat slender thread. Still, the connecting theme is readily traced, especially by readers familiar with the striking theories and generalisations with the exposition of which the author's name is associated. It is hardly necessary to say that everyone interested in plant life should read this little book, which is written in a most attractive style. For those who wish to go more deeply into the subject it will serve as an introduction to the study of the author's larger work, one of the most important contributions to botanical literature in recent years.

F. C.

Links with the Past in the Plant World.—By A. C. SEWARD, M.A., F.R.S. 142 pages. 20 figures. $6\frac{1}{2}$-in. × $4\frac{1}{4}$-in.

(Cambridge University Press. Price 1/- net.)

The author of this most readable and interesting book has hit upon a capital method of approaching the study of ancient plants from that of existing species, and deals largely with certain types and groups which have survived from early times to the present day. The first four chapters, on the longevity of trees, the geographical distribution of plants, the geological record, and the preservation of plants as fossils, are simply packed with information, while written in the author's usual lucid and scholarly style and therefore avoiding the least semblance of compression. Much of the matter contained in these chapters has been gleaned from sources outside the usual range of the botanical student's reading, giving a welcome freshness of treatment to familiar topics. The rest of the book is concerned with such present-day types and groups as have outstanding claims of long descent, and with their importance in relation to the great dominant groups in the vegetation of the remote past. We have but one fault to find with the last two chapters, dealing with the Araucariaceae and with *Ginkgo*, on which the author has done so much research work—these chapters are far too short. But then the same might be said of the book as a whole!

F. C.

Plant Life.—By E. WARMING; translated by M. M. REHLING and E. M. THOMAS. 244 pages. 249 figures. 7 in. × 5 in.

(George Allen & Co. Price 4/6 net.)

The launching of still another elementary text-book of Botany upon the well-stocked market is an enterprise that requires some justification in these days, and this is especially the case when the book has been translated from a foreign language. However, there can be no doubt that many students and teachers will welcome Professor Warming's book, which has many admirable features and presents in many respects the excellent qualities which have made some of his larger works acceptable in various languages besides the original Danish. The present translation, however, might have been improved by a good deal of pruning and modification, in order to adapt it better to use in this country. It appears somewhat feeble to translate matter which is quite irrelevant so far as English readers are concerned, as, for instance, the three species of *Anemone* taken at the beginning of the chapter on classification, or the chapter on Danish plant-formations. True, the translator's notes indicate that these parts of the book are not applicable to this country, but it would have been much better to "naturalise" the book by incorporating suitable matter. However, a good many little points betray the lack of that thorough knowledge of the subject which would have enabled the translators to attempt this naturalisation process with success, so perhaps things are just as well as they are. There are some misprints, and Figure 243 is upside down.

F. C.

Plant Physiology.—By B. M. DUGGAR, Ph.D. 516 pages. 144 figures. $7\frac{3}{4}$-in. × $5\frac{1}{2}$-in.

(Macmillan & Co. Price 7/- net.)

This handy manual contains an immense amount of carefully compiled and well-selected information, and is about the best of the smaller text-books of plant physiology that we have yet seen. Though specially adapted for the use of students of agriculture and horticulture, it is a book which the purely botanical student may use with decided advantage, while its direct and simple style of presenting the subject should attract an even wider circle of readers. A valuable feature of the book is the list of references to literature given at the end of each chapter, indicating the sources from which the latest and most detailed information on each topic may be obtained. As the author justly claims, a subject like plant physiology gains decidedly in interest when the illustrations are drawn largely from plants which are familiar and useful, and the relations of this science to plant production are kept in view throughout. The book is thoroughly up-to-date, as is shown by the treatment of such topics as balanced solutions, etherization, light-perception organs, and so on.

F. C.

The Forest Trees of Britain.—By the late Rev. C. A. JOHNS. Tenth edition, revised by G. S. BOULGER, F.L.S., F.G.S. 431 pages. 16 coloured plates and numerous other figures in the text. 8-in. × $5\frac{1}{4}$-in.

(Society for Promoting Christian Knowledge. Price 6/- net.)

Although this book was published originally in 1869, the editor of the present re-issue has thought it best to present the work very much as the author left it. The result is that, while a book like this cannot possibly challenge comparison with the many excellent works on British trees which have appeared in recent years, it is still eminently readable and interesting. Some of the old cuts are exceedingly poor and often quite unrecognisable, but some good photographic illustrations have been added in this reprint. This volume is a perfect mine of quaint and curious facts and fancies about trees, and forms an interesting supplement to more scientific works from which the sort of information compiled by Johns is usually rigorously excluded. Johns' "Forest Trees" was in its day highly esteemed, as presenting the artistic and folk-lore aspects as well as the structural characters of trees, and it is for the former rather than the latter that it may still find a place in the literature of Botany. F. C.

Four Place Tables.—By E. V. HUNTINGTON. 33 pages. 9-in. × 7-in.

(Mass.: The Harvard Cooperative Society, Cambridge.)
(London: E. & F. N. Spon. Price 3/- net.)

A casual glance at the thirty-two pages of this book, followed by a reference to the price (sixty cents in America, in London 3s. net.) induced a closer study with a view to discovering the cause of this comparative costliness. There are a good many distinctive merits in the book. First of all, by the arrangement of tabs on the margin, it is made easy to manipulate the book with the left hand and turn rapidly from one table to another. Next there is no table of anti-logarithms, which like tobacco and alcohol are luxuries and bad for the young. Then, in addition to the ordinary table of logarithms of numbers from 100 to 999, there is a special table from 1,000 to 1,999; and the same device for saving interpolation is adopted in the case of the logarithms of the trigonometrical functions for angles between 0° and 10° and between 80° and 90°. There are tables for conversion from minutes into decimals of a degree and vice versâ, also for squares and square roots, cubes and cube-roots, reciprocals, e^{n} and e^{-n}, Napierian logarithms and useful constants. The directions for use are clear and brief. Altogether the book deserves a trial. W. D. E.

Table of Logarithms and Anti-logarithms (Four figures).—By MAJOR HANNYNGTON, F.S.S., F.I.A. 41 pages. 8½-in. × 5½-in.

(Charles & Edwin Layton. Price 1/6 net.)

This small book of logarithms is intended for the computer. It should prove very handy and convenient, for it is very clearly arrranged and the printing is good. A. C. E.

Table of Logarithms and Anti-logarithms to five places of Decimals.—By E. ERSKINE SCOTT. 383 pages. 9-in. × 6-in.

(Charles & Edwin Layton. Price 5/- net.)

The publishers preface this volume of logarithms and anti-logarithms by a note stating that they hope the book may suit the requirements of students better than the more costly edition issued in 1892. The tables are clearly arranged, the first column containing numbers up to four places of decimals. The book is necessarily rather bulky, containing 383 pages, but its clearness makes up for this fault perhaps. The anti-logarithms are printed on green paper, which avoids chance of mistaking them for logarithms. A. C. E.

ORNITHOLOGY.

The Great Auk.—By THOMAS PARKIN, M.A., F.L.S., F.Z.S. 36 pages. 5 plates. 8½-in. × 5½-in.

(Hastings: Burfield & Pennells. Price 2/-.)

Mr. Thomas Parkin has been at very considerable pains to bring together the records of all the sales by public auction of the Great Auk and its eggs between the years 1806 and 1910. We find from his book that previous to the year 1869 the value of a Great Auk's egg ranged from twenty to thirty pounds. In 1869 the price had risen to sixty pounds, in 1880 to one hundred, and in 1888 to two hundred and twenty-five, while six years later three hundred and fifteen was reached, and in 1900 the record price was obtained, namely, three hundred and thirty pounds fifteen shillings. It will be seen on page 194 of this number that at a recent sale two eggs fetched only about half this sum, but as Mr. Stevens pointed out at the time they were not first-class specimens, and he had no doubt but that a really good one would still fetch a big price. It may be mentioned that with one exception (when a specimen was disposed of as part of a collection in 1908) all the Auk's eggs sold for more than twenty pounds have been knocked down at Stevens's. There are two instances, however, of outside sales where the buyers got two eggs for a song. The Kent sale is mentioned on page 194 of this number. Fourteen years previously (in 1880) Mr. Small picked up two eggs at Edinburgh for thirty-two shillings. For one of these Lord Lilford gave one hundred pounds and for the other, one hundred and seven pounds two shillings. Only five records of the sales of the bird itself are given by Mr. Parkin. The record price is three hundred and fifty pounds, obtained in 1895, while the last sold realised three hundred and fifteen pounds. The author learns from Mr. Edward Bidwell, who has made a special study of the subject, that there are now eighty skins in existence and seventy three eggs.

The frontispiece to the pamphlet is from a photograph taken at Stevens's during the sale of an Auk's egg. Plate II is from a life-sized photograph of an egg in the possession of Mr. Parkin. Plate III shows another egg, Plate IV a stuffed specimen of the bird with an egg, and Plate V the London Museum, otherwise known as the Egyptian Hall, in which there used to be two eggs. One of these and a specimen of the bird were bought by Dr. Leach for the British Museum in 1819 for sixteen pounds fifteen shillings and sixpence, while the other egg only fetched between ten shillings and a pound. W. M. W.

PHYSICS.

Laboratory Problems in Physics.—By F. T. JONES and R. R. TATNALL. 81 pages. 67 illustrations. 7¾-in. × 5-in.

(Macmillan & Co. Price, 2/6.)

A useful laboratory manual, containing hints for practical work in Elementary Mechanics, Hydrostatics, Sound, Heat, Electricity and Magnetism, and Light, in the order given. A feature worthy of note is the prominence given to Revision questions and applications. The diagrams are clear, and teachers may gather some useful hints from them. In particular, a simple water trap for "heat of vaporisation" has caught our eye. The order of subjects is, of course, largely a matter of individual taste; but the problems on Electricity and Magnetism are arranged in a sequence differing in many respects from that usually adopted in English schools. In many instances the experiments are expressly headed "Review Experiment," calling attention to the opinion expressed by the authors that a preliminary view of the subject (presumably in lecture) should precede the laboratory work in such cases. Many teachers of physics will probably agree with them. W. D. E.

Physicochemical Calculations.—By JOSEPH KNOX, D.Sc. 188 pages. 7½-in. × 5-in.

(Methuen & Co. Price 2/6.)

This book is based on Abegg and Sacken's; "Physikalisch-Chemische Rechen Anggaben," but it is not a mere translation, for the book is arranged carefully in subjects, and a short introduction to each chapter and new set of problems has been written. It should prove valuable to the teacher of physical chemistry as well as the student. A. C. E.

Waves and Ripples in Water, Air, and Aether.—Second issue. By J. A. FLEMING, F.R.S. 299 pages. 85 illustrations. 8-in. × 5-in.

(Society for Promoting Christian Knowledge. Price 2/6 net.)

Many of those who attended Professor Fleming's lectures at the Royal Institution on the above subject, wished that he would reproduce them in print: their popularity may be gauged by the fact that this is the second issue. Professor Fleming describes numerous experiments to illustrate in a manner intelligible to the majority of readers the most interesting phenomena of wave motion. Water waves and waves made by ships, sound waves, and electromagnetic waves, are examined and the results expounded in a delightfully clear manner. Just as Turner on being reproved for his idleness, when he spent a morning throwing stones into a pond, replied that he had not been idle, but had learnt how to paint a ripple, so no one who intelligently follows Professor Fleming through the pages of his book will have misspent his time. It is surely an added [illegible] the intricate processes at work in the propagation of [illegible] a thing as a wave in the sea, but it is even more [illegible] to learn to appreciate the unseen beauties which [illegible] a Hertzian wave.

A. C. T.

Soap Bubbles: Their Colour and the Forces which Mould them. (New edition.) By C. V. Boys, F.R.S. 190 pages. [illegible] illustrations. 7-in. × 4¾-in.

(Society for Promoting Christian Knowledge. Price [illegible].)

This book is also another edition of a series of popular lectures on a most entrancing subject, so popular that the distinguished author in his preface mentions that already "two tons of tiny bubbles are floating about the world." No one could help being fascinated by the appearance of a soap bubble, and if that fascination means anything it would give rise to a desire to learn more of the processes of nature which cause such beautiful phenomena. The book is full of experimental work on soap films of the most interesting nature, and it is not necessary to go further than to recommend it to everyone interested in scientific phenomena.

A. C. T.

BRIEF NOTICES OF BOOKS.

The list includes books which have been received since the last number of "KNOWLEDGE" *went to press.*

ASTRONOMY.

Annuaire Astronomique pour 1913. By L'OBSERVATOIRE ROYAL DE BELGIQUE. 516 pages. 6 illustrations. 7½-in. × 4¾-in.

(Brussels: Hayez, Imprimeur de l'Observatoire Royal.)

We welcome the annual volume published by the Royal Observatory of Belgium, which has been issued without intermission since the year 1834. The meteorological observations were separated from it in 1901 and have since been published by themselves.

Catalogue of 9812 Stars.—By T. W. BACKHOUSE, F.R.A.S. 168 pages. 12½-in. × 10-in.

(Sunderland: Hills & Co. Price 10/6.)

This catalogue of all the stars which are very conspicuous to the naked eye is applicable to the epoch of 1900, and it is intended to be used with fourteen large star maps. The preface of nearly twenty pages explains its construction and application.

BOTANY.

The Life of the Plant.—By C. A. TIMIRIAZEFF. 355 pages. 84 illustrations. 9½-in. × 5¾-in.

(Longmans, Green & Co. Price 7/6 net.)

Miss Anna Cheréméteff has translated the seventh Russian edition of Professor Timiriazeff's book to form the volume under consideration. The various plant organs are considered in detail in special chapters prefaced by one dealing with special structure and another on the cell, while the plant again at the end of the book is compared with the animal, the origin of organic forms is discussed, and an appendix deals with the plant as a source of a supply of energy.

A Manual of Structural Botany.—By HENRY H. RUSBY. 248 pages. 599 illustrations. 9½-in. × 6-in.

(J. & A. Churchill. Price 10/6 net.)

Dr. Henry Rusby is Professor of Materia Medica in the College of Pharmacy in the city of New York (Columbia University), and while his book claims to be a fairly complete introduction to Botany it has been written with special reference to the needs of a first year's student of Pharmacy.

CHEMISTRY.

Smoke—A Study of Town Air.—By JULIUS B. COHEN, Ph. D., B.Sc., F.R.S., and ARTHUR G. RUSTON, B.A., B.Sc. 88 pages. 35 illustrations. 9-in. × 6-in.

(Edward Arnold. Price 5/- net.)

This small book deals with soot, its effects on vegetation, the gaseous impurities of air, town fog, and contains appendices on the influence of coal smoke on health and the soot fall of London.

GARDENS AND GARDENING.

Oxford Gardens.—By R. T. GÜNTHER, M.A. 280 pages. 33 illustrations. 7¾-in. × 5¼-in.

(Parker & Son. Price 6/- net.)

Mr. Gunther's work is based upon Daubeny's Popular Guide to the Physic Garden of Oxford, and has been brought out because neither the Guides written by Dr. Daubeny nor the Garden itself are as well known as they ought to be. During the greater part of the nineteenth century the garden was evidently unknown as a University Institution to the compilers of the University Calendar. Only within the last few years has it been included in the list of University Institutions, and this recognition has coincided with the residence of the Secretary of the delegates of the University Press in a house overlooking the Garden. Mr. Gunther has added notes on the gardens of the colleges and on the University Park, as well as two good indexes.

Annuals, Hardy and Half-Hardy.—By CHARLES H. CURTIS. Edited by R. Hooper Pearson. 116 pages. 8 coloured plates. 8½-in. × 6¼-in.

(T. C. & E. C. Jack. Price 1/6 net.)

The latest contribution to the excellent series of books entitled "Present-Day Gardening" is the volume on Annuals, Hardy and Half-Hardy. Its coloured illustrations are as usual by Mr. Ernest Waltham, who is greatly to be congratulated on the result of his work.

GEOLOGY.

Earth Features and their Meaning.—By WILLIAM HERBERT HOBBS. 506 pages. 493 figures. 24 plates. 8¼-in. × 5¾-in.

(Macmillan & Co. Price 12/6.)

Professor Hobbs has prepared an expanded form of a course of illustrated lectures delivered in the University of Michigan. The subjects selected for study are those dominant geological processes which are best illustrated by features in North America and Europe. Professor Hobbs thinks that to combine in a single text book historical, dynamical and structural geology is to make the volume unnecessarily encyclopaedic and correspondingly uninteresting to the general reader.

METAPHYSICS.

A Mathematical Theory of Spirit.—By H. S. REDGROVE. 125 pages. 8-in. × 5¼-in.

(William Rider & Son. Price 2/6 net.)

This book is an attempt to elucidate certain metaphysical problems by the aid of mathematics. The needs of the non-mathematical reader have, however, been constantly kept in view.

Is the Mind a Coherer?—By L. G. SARJANT. 304 pages. 7½-in. × 5-in.

(George Allen & Co. Price 6/- net.)

Some extracts from the "Contents" of this book will give an idea of what it contains. Among the essays which take the place of chapters we find some with these headings, "Does Matter become Mind?"; "The Mind a Coherer"; "Non-conversion of Matter to Mind"; "[illegible] Interest"; "Why do we not all think alike?" and "Law that defeats itself."

PHYSICS.

Studies in Terrestrial Magnetism. By C. Chree, M.A., F.R.S. 206 pages. 43 illustrations. 9-in. × 6-in.

(Macmillan & Co. Price 5/- net.)

Dr. Chree's object in publishing his studies is to give a connected account of his own original work.

TOPOGRAPHY.

To the West of England by Canal. By Robert J. [illegible], F.R.G.S. 6[illegible] pages. 16 illustrations. 7-in. × 4½-in.

(J. M. Dent & Sons. Price 9d.)

This small book is one of "The Educational Journey Series," and is concerned with the topography, scenery, geology, as well as the works of primitive and later man, along a line running from Reading to Bristol.

CORRESPONDENCE.

THUNDERSTORMS.

To the Editors of "Knowledge."

Sirs,—I see in a recent issue of "Knowledge" Mr. Tankerville-Chamberlayne remarks on the curious fact that one never hears of anyone who has observed a thunderstorm commence overhead. No doubt it does strike one as singular until you begin to calculate and see how often such a fact would be observed.

If we consider that any flash of lightning is more or less overhead which occurs in a circle of one-and-a-half or two miles diameter, and that thunder can be heard probably at least fifteen miles away, that is, in a circle of thirty miles diameter, we see that the ratio of storms beginning overhead to those not thus beginning is one to four hundred or one to two hundred and twenty-five, for the area of the large circle is from two hundred and twenty-five to four hundred times that of the small one. Taking an average of ten thunderstorms a year, we see that on an average only once in about thirty years would any individual experience the commencement of a storm overhead, and any one might easily forget an event happening so rarely. I see some authorities put down ten miles as the limit of audibility of thunder, but in this land of far distances, where you can see a storm playing over a kopje twenty miles distant, and can thus be sure of the distance of the thunder cloud, you will, I think, find that eighteen or twenty miles is not too far off to hear thunder. Under favourable circumstances I should not be surprised if I heard it even more than that.

THEODORE B. BLATHWAYT.

Cape Town.

PRIMITIVE CONSTELLATIONS.

To the Editors of "Knowledge."

Sirs,—A writer on the "Primitive Constellations" is responsible for this statement: "The catalogued Tablets in the K collection of the British Museum alone number fourteen thousand two hundred and thirty, the far greater portion of which are astronomical. Most of these have yet to be examined." In the November part of "Knowledge" you have given us Professor Bickerton's confession, "Astronomy has become somewhat dry and arid. Official astronomers do not care for theories, for the linking silken cords of correlation," and so on. Now, I believe the astronomical knowledge of the Babylonians commands our highest respect, and it is quite possible that even in these enlightened days we may learn much from their imperishable records. Amidst the wrangle amongst scholars, is there not one that can clear up the mystery and speak with unquestionable authority on the *origin* of the old constellation figures and what they were meant to depict?

Are these figures pictorial representations of absurd Greek myths, or are we to go beyond the times of Greece?

Why should this branch of astronomy be left buried in the dust-heap of the ages? Perhaps some of your readers have gone deeply into these things, and could publish an article that would stimulate and guide others who are groping for light along these lines.

D. S. B. SQUIRE.

Hobsonville,
Auckland, N.Z.

NOTICES.

PHOTO-MICROGRAPHY.—We may remind our readers that Mr. E. Senior's course of practical demonstrations on Photo-micrography begins on May 6th, and will be continued on the five following Mondays, from 7.30–9.30, at the South-Western Polytechnic, Chelsea.

RESEARCH DEFENCE SOCIETY.—Sir David Gill, K.C.B., F.R.S., has succeeded Lord Cromer as President of the Research Defence Society, and Lord Cromer, the Right Hon. A. J. Balfour, Sir Edward Elgar, O.M., Mr. Rudyard Kipling, and Lord Rayleigh, O.M., have consented to be Vice-Presidents of the Society.

THE ROYAL INSTITUTION.—The following Lectures will be given on Friday evenings at 9 o'clock during May:—(3rd) "The Use of Pedigrees," by Mr. W. C. Dampier Whetham, F.R.S.; (10th) "The Gaumont Speaking Cinematograph Films," by Professor W. Stirling; (17th) "High Frequency Currents," by Mr. W. Duddell, F.R.S.; (31st) "Icebergs and their Location in Navigation," by Professor Howard T. Barnes, F.R.S., who will also deliver the Tyndall Lectures on "Ice Formation in Canada" on Thursdays (16th and 23rd), at 3 o'clock. On Tuesdays (14th and 21st) Professor Bateson, F.R.S., will lecture on "The Study of Genetics."

BEDROCK: THE NEW SCIENTIFIC QUARTERLY REVIEW.—The first number of this magazine has appeared and contains seven articles, all of which are worthy of most careful reading. Professor Welton's twenty pages show the position and usefulness of logic at the present day. As dealing with the interpretation of facts the writer points out that a complete employment of logical method may be the work of several minds, that the interpreter is not always the observer or not alone the observer, just as he frequently is not the only verifier, is never the only elaborator. Professor Welton agrees with Professor Turner's insistence (Address to the Mathematics and Physics Section at the British Association in 1911) on exact knowledge of facts and his warning against premature hypothesis, but Professor Welton urges that the idea that collected facts—or records of facts—"tell their own tale," may have, and often has had, disastrous consequences to science.

Mr. Archdall Reid devotes a good many pages of his paper on Recent Researches in Alcoholism to a discussion on natural selection as it affects mankind. He still emphasises his contention that a race must be drunk before it is sober, and that it is by natural selection weeding out those who cannot withstand diseases or succumb to the temptation of drugs, that we get comparative immunity in a race to a particular disease or a deleterious habit. Dr. Gossage in the last article, when discussing "Human Evidence of Evolution," offers other explanations. Professor Poulton has a good deal to say in praise of the way in which Bergson has put forward his theory of evolution as depending upon creative internal developmental force, but, nevertheless, in the two instances which are brought forward, namely, the nature of instinct and the growth of a mimetic resemblance, Professor Poulton shows without difficulty that the Darwinian interpretation can explain the results, whereas the Bergson solution breaks down entirely.

and he infers from this that it is probable that the same thing would happen when the rival hypotheses are pitted against each other in any part of the field of evolution. The writing of the article has given Professor Poulton the opportunity of bringing forward some very interesting cases of mimicry where the male of one butterfly is mimicked by the female of another, and his article will appeal to everyone who is interested in Protective Coloration and Evolution generally. Professor Turner's contribution to the first number of *Bedrock* is substantially the Halley Lecture which he gave in 1911. Of a different character is Professor Gibson's consideration of "The Inter-action between Passing Ships." The Hermit of Prague in his remarks on "Social and Sexual Evolution," says that: "What humanity wants is such a social organisation as will allow every normal citizen to obey the two fundamental commandments that Nature has prescribed for all living things. These two commandments are (1) Thou shalt enjoy the fruits of the earth; (2) Thou shalt reproduce. But it is only when the society to which he belongs is so organised as to afford him a full assurance of his being able to obey the first, that *homo sapiens* can fearlessly obey the second."

The contents of *Bedrock* should arouse several interesting and important discussions, and we look forward with pleasure to the appearance of the next number.

WHO'S WHO IN SCIENCE.—This useful work, published for the first time this year, gives brief details of many men of science and a list of the senior professors in the universities of the World, as well as a classified index of the surnames (under the headings of each science) of workers in various countries. The new issue for 1913 will contain a section devoted to scientific societies, and as time goes on there is no doubt but that "Who's Who in Science" will become quite indispensable to all workers in science.

DEW PONDS.—In the April number of *The Journal of the Board of Agriculture*, Mr. Edward A. Martin, F.G.S., in the course of an article entitled "Ponds in Agricultural Districts" discusses the subject of Dew Ponds, to which he has paid much attention. He says that in the course of his experiments he has found no less than ten different methods of making a waterproof bottom. The principal constituent is puddled clay or chalk. He comes to the conclusion that there is no necessity for straw to be used in the process except as a temporary precaution against cracking during the making. A well-made puddled pond, he concludes, will outlast many cemented or concrete ones.

GANONG BOTANICAL APPARATUS.—We have on a previous occasion made mention of the apparatus designed by Professor Ganong for the use of his students. He has endeavoured to "develop such appliances, that is, tools, as shall fit their exact task, be applicable thereto with celerity and convenience, give quantitative results of minimal error and be obtainable at all times from the stock of a supply company." The Bausch and Lomb Optical Company, in whose hands the work of manufacture has been placed, have sent us their latest catalogue in which there are described in detail seventeen pieces of apparatus which will be found most useful in the study of plant physiology. These include a clinostat, by means of which a growing plant may be made to revolve in practically any position, as well as devices for demonstrating root pressure, respiration and transpirations.

YACHTING GLASSES.—Messrs. Ross have sent us a special list of British-made glasses, including a naval telescope and two binoculars, the "Night" glasses, which give the maximum illumination and field, and the "Naval Prism" binocular, magnifying six times and recommended because of its great stereoscopic power.

LENSES AND CAMERAS.—The same firm has issued its photographic list for the year 1912, which contains several new lenses and cameras, e.g., the extra-rapid "Homocentric" lens, working at $f\,4{\cdot}5$. This lens is due to a development of the mathematical formulae of Gauss, which has been possible owing to the new kinds of glass available. The features which have been aimed at in the new "Telecentric" lens are critical definition with full aperture, and large image with short camera extension. A folding reflex camera has been introduced, and a minor "Multispeed" shutter, which is less expensive than the original one of that name, and is not intended for such extremely high speeds.

MONSTROSITIES AMONG MARINE FISH.—The Director of the Oceanographical Museum of Monaco, Dr. J. Richard, points out in *La Nature* for April 13th, that monstrosities are fairly common among certain fresh-water fish, and he gives a series of pictures of abnormal sea fish which are part of the collection of the museum under his charge.

PHILIPS' MONTHLY WEATHER CHART is a foolscap sheet of paper, ruled and headed, for the graphical representation of the daily observations of pressure, temperature, wind and rainfall, with, in addition, spaces for initials indicating the weather. For those observers who wish to set up their observations in the form of curves, this chart will be found convenient and useful. The price is one penny per sheet.

SECOND-HAND INSTRUMENTS.—As usual, Mr. C. Baker's catalogues of second-hand instruments and photographic apparatus should prove exceedingly useful. The first contains seventy-four pages dealing with microscopes, telescopes, surveying instruments, physical apparatus, and so on, while the other classified list, which is now published separately, runs to twenty-seven pages and gives details of second-hand cameras and lenses.

RAINFALL IN AUSTRALIA.—Mr. H. A. Hunt, the Government Meteorologist for Australia, has just issued the Rainfall Map for 1911. In that year about twenty-five per cent. of the total area of the Commonwealth had rainfall in excess of the average, and in Victoria the year was the wettest experienced since accurate observations began in 1850. The heavy rains, however, were not so widely spread as in 1910, when seventy-five per cent. of the total area had rainfall above the average.

Both in Australia and in Tasmania the excess rainfall in 1911 was experienced mainly in the eastern regions.

THE MISUSE OF LANTERN SLIDES.—*Science* for April 5th, 1912, publishes part of a paper read by Dr. C. H. Townsend at a meeting of Curators of Public Museums in New York. The title is "The Misuse of Lantern Illustrations by Museum Lecturers," but the remarks refer in a great measure to lecturers generally. A recent ornithological congress is described as a lantern-slide competition. Dr. Townsend is convinced that what we have come to call lecturing is not the real thing. It is a presentation to the eye, rather than to the mind, and the audience accepts it passively. He asks also, "Shall we continue to supply sugar-coated science until even the more discriminating part of the public begins to think that the professional ornithologist is really no better than the enthusiastic amateur who could photograph birds just as well"? The museums, however, are asked why they disregard the fact that the amateur's slides may be better than theirs. The question of written lectures is dealt with and various misguided efforts. In conclusion, Dr. Townsend suggests that we should illustrate our lectures and cease to lecture about our illustrations. The whole topic is one of considerable importance, and would form a good subject for discussion in the columns of "KNOWLEDGE."

THE CINEMATOGRAPH IN SCHOOLS.—As bearing on the subject of lantern slide exhibitions we may quote a paragraph from *The University Correspondent* for April 15th:—"Mr. A. P. Graves, ex-H.M.I., has been lecturing to the students of a Dublin training college on the use of cinematographs in school teaching and recent developments in that way. He suggested that educationists should 'domesticate the cinematograph, and make it a tame creature,' and said that Sir Ray Lankester has prophesied that within a year from now there will be machines of the kind at work in all the London Council schools."

// Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JUNE, 1912.

FERMENTS AND FERMENTATION.

By DAVID FRASER HARRIS, M.D., B.Sc. (Lond.), D.Sc. (Birmingham).

Lecturer on Physiology, the University, Birmingham.

Continued from page 180.

THE cells must be able to pass something out through their envelopes, something which can alter the state of the sugar, and this something must of necessity be a ferment and a soluble one or enzyme. Thus, after all, the insoluble ferments act by means of soluble ones. A worker of the name of Büchner was the first to obtain the enzyme of yeast from the interior of the cells: Large quantities of yeast-cells were crushed under great pressure when a liquid was obtained which, at a suitable temperature, fermented sugar to alcohol. This ferment from the interior of cells was named "zymase" and may be alluded to as an endo-enzyme. (It is now customary to make the names of ferments end in "ase.") This method of obtaining a press-juice has been extensively used to extract endo-enzymes from both vegetable and animal cells. An excellent example of an endo-enzyme of animal origin is the ferment found in the mammalian liver, which transforms the insoluble glycogen, or animal starch, deposited there into the soluble sugar which passes out of the gland into the blood to be distributed to the body. This ferment, glycogenase, is extractable from the liver even after it is dead, has been dried and kept a long time under alcohol: it is normally an intra-cellular ferment, but it can be extracted, isolated and made to do its work outside the body altogether in a glass vessel. It is itself not living, but it is the product of the living liver cells. It does not possess life, but it is possessed by life, and is the agent deputed by the living stuff to perform what would at one time have been deemed an exclusively vital function.

We might try to get some idea of the different kinds of chemical work which enzymes do: in other words classify them:

(1) The digestive—those which dissolve respectively each of the constituents of our diet: proteins (proteolytic), starches (amylolytic), and fats (lipolytic), and many others in animals and plants.

(2) Those which dissolve cellulose (cytase) and starch (diastase), ferments active in the ripening of fruits and seeds.

(3) The coagulative—those which clot milk, blood, lymph and muscle.

(4) The oxidases, or oxygen-carrying ferments, such as the uricolytic ferment which oxidises uric acid to urea, and lactidase which oxidises lactic acid to alcohol and carbon dioxide.

(5) Respiratory or tissue ferments allied to the above group: at present being investigated: probably with reducing-powers.

(6) The alcohol-producing ferments, capable of acting on many sugars.

(7) The acetic-acid-producing ferments, the cause of the souring of wine.

(8) The lactic and butyric acid producing ferment, the cause of the souring of milk.

(9) Those which oxidise ammonia in the soil to nitrites and nitrates: nitrification ferments.

(10) Those which fix atmospheric nitrogen in the roots of certain plants: the "nitro-bacteria."

(11) The ferment which converts urea into ammonium carbonate, urease.

(12) Those producing coloured substances from colourless chromogens.

(13) Those which produce luminosity in certain lowly forms of animal life: "luciferase" acting on the "luciferin."

This list is by no means complete: it does not include the putrefactive, or the various disease-producing forms. But those mentioned are actively engaged in the everyday life of some plant or animal. In fact the whole vital field is occupied by them. The meaning of the action of most of them is sufficiently obvious: from our own personal point of view the digestive are the most important. Were it not for them our food would remain exactly as swallowed, insoluble and unabsorbable: without them we should starve though eating abundance. Many tissue-ferments only just being recognised are of immense importance. Take the case of a starving man or animal. We say in such a case the organism "lives on" its muscle and on its fat: but that explains nothing. Endo-enzymes have been discovered which dissolve the muscle and the fat of the body so that soluble substances can get into the blood and thus be carried to the heart and nervous system for their nourishment. Hence after a period of starvation or hibernation, the animal is found to be exceedingly thin: its tissues have literally been dissolved away.

The rôle of the putrefying and nitrifying ferments is of the highest importance in the maintenance of animal life, and in the continuous circulation of nitrogen which goes on. As soon as an animal is dead, millions of bacteria set about dissolving its tissues into a large number of different chemical substances such as amides, amino-acids, ammonia, compounds of sulphur, marsh gas, and certain highly poisonous substances to which such names as "cadaverine," "putrescine," have been given. Some of these are gaseous and escape into the atmosphere: those containing nitrogen are attacked by the nitrifying micro-organisms and converted into salts which are utilised as the food of plants. The plants form vegetable proteins which are eaten by herbivora: man and the carnivora eat the herbivora so that "all flesh *is* grass." "Imperial Caesar dead and turned to clay" does not remain "clay." His imperial nitrogen undergoes many vicissitudes, and may conceivably, in course of time, even become part of the body of a descendant.

The respiratory ferments believed to reside in the depths of the tissues are exciting a good deal of attention at the present time. It is now coming to be believed that the tissues actually obtain their oxygen from the blood by aid of a reducing-ferment or "reductase" which hands over the oxygen to an oxidase which applies it to the oxidation of the carbon and hydrogen of materials in the cells, with the consequent liberation of heat.

A particularly interesting ferment has lately been recognised in certain coloured flowers: the beautiful colour of a purple or pink sweet-pea is due to the interaction of a chromogen with an enzyme. If either one or the other is absent the flower is white: the chromogen alone gives a white petal, so does the enzyme alone.

We might now look into the various characters possessed more or less completely by all ferments.

The first characteristic common to them all is that they cannot work in the absence of water. Expressed chemically this is, that they act by hydrolysis. The fungi and the bacteria, as well as the enzymes, are quite inert when dried up. Yeast in a dry state will not ferment dry sugar: boots must be damp to have the growth of green mould on them: it is because jam is moist that fungus grows on it: no perfectly dry thing will decompose. It was because it was sun-dried that Livingstone's body was able to be preserved in Central Africa and brought to England for burial.

The second characteristic is the excessively minute quantity of the enzyme which is able to transform an enormous quantity of material acted on (substrate). Thus one part of rennin, the milk-clotting ferment, can clot four hundred thousand parts of milk: one part of pepsine in seven hours can digest five hundred thousand parts of fibrine.

The third point is that the ferments, like true catalysts, do not incorporate themselves with the products of their activity: pepsine is recoverable after it has peptonised.

The fourth feature of ferments is their affectability towards changes of temperature. A ferment of whatever kind can be active only within a certain range of temperature, and within that range there is a particular temperature at which the ferment works most rapidly: this is called its "optimum temperature." On each side of the optimum the ferment works less and less energetically or perfectly. As the temperature rises the ferment is inhibited, and at last a temperature is reached at which it ceases to work altogether. This is the destruction or "death" temperature, the ferment will not work again under any conditions. As one lowers the temperature from the optimum, the ferment is similarly progressively inhibited until it ceases to work altogether, but can work again when the temperature is raised. But no low temperature has been reached which destroys ferments in the sense that a sufficiently high temperature does. Professor MacKendrick kept organisms of putrefaction for a hundred hours at minus 83°C.—a temperature sufficient to freeze alcohol—without killing them. Putrefaction was arrested, but, on the temperature being raised, became as active as ever. Similarly, the late Professor Macfadyen found that the temperature of liquid air (minus 250°C) would not kill certain disease-producing bacteria: the present writer has found that twenty-four hours' exposure of liver and kidney press-juice to as low a temperature as minus 11°C does not in the least impair the subsequent capability of chemical reduction possessed by a tissue-ferment provisionally known as "tissue-reductase."

The fifth characteristic of ferment action is the tendency of the ferments to be inhibited by the accumulation of the products of their own activity. Thus alcohol rising to 11% puts an end to the alcoholic fermentation in wine-making, the presence of peptones restrains pepsine, and similarly in other cases. The toxines of disease germs inhibit the activity of the micro-organism: when this happens in a living person, the person recovers. Of course within the body an accumulation inhibitory to the digestive enzymes does not occur, owing to the constant absorption normally going on in the digestive processes.

An exceedingly interesting chapter in fermentation is that dealing with the activators or the kinases as they are called. Not all enzymes exist at all times in an active state: certain enzymes are secreted in an inactive state, and may remain inert until some substance—which is not always a ferment—has reached them to activate them. These activators may be dilute acids, sometimes they are other ferments (kinases). Thus pepsine does not exist in the active state in the cells of the gastric glands, but in an inactive (zymogen) condition; this antecedent state being known as pepsinogen. As soon, however, as the hydrochloric acid of the gastric juice gains access to the pepsinogen, it converts it rapidly into the active pepsine. Thus the old puzzle, "why does the stomach not digest itself," is solved. The answer is, the gastric glands do not contain the active form of the ferment, but only the inactive, or zymogen. A very interesting case of ferment activation has been discovered within the last few years. Freshly secreted pancreatic juice does not of itself digest albumins, neither does pure intestinal juice—the *succus entericus*—but if a very little succus be added to the pancreatic juice, a most powerful digestive action is developed, trypsinogen has been activated. Now, since the addition of boiled succus entirely fails to activate pancreatic juice, we seem justified in believing in the existence of an enzyme in the intestinal juice whose office it is to activate the pancreatic: this kinase is called entero-kinase.

Enzymes are not only exceedingly sensitive to variations of temperature, but also to the chemical reaction of the medium in which they find themselves. Thus ptyaline of the saliva can convert starch to sugar only in a slightly alkaline or neutral medium, pepsine can act only in an acid medium and really well only in presence of hydrochloric acid from 0·2% to 0·4%, while the pancreatic enzymes all need frankly alkaline surroundings. Departures from the normal acidity in the stomach constitute certain forms of dyspepsia.

Again, certain ferments only act properly in presence of lime salts. Such are rennin, the milk-clotting, and thrombase, the blood-clotting enzyme. The discovery of anti-ferments is one of the most curious in this interesting subject. It explains another old puzzle which was, "Why are the parasitic intestinal worms not digested by the intestinal juices of their hosts"? The answer is that the worms have actually acquired the power of producing a ferment which antagonises the trypsine of the pancreatic juice; that is, an anti-trypsine which effectually prevents the tryptic enzyme exerting its solvent action on them. This is a remarkable example of adaptation to environment.

The last characteristic of ferments which may be noticed is their specificity, individuality, or mutual non-interchangeableness. Thus pepsine can act on proteins, and on these alone; it is quite powerless to digest starch or pure fat. Similarly the starch-dissolving enzymes are absolutely inert as regards proteins or fats.

But more than this as indicating a high specificity, only those sugars containing six or nine atoms of carbon are capable of alcoholic fermentation. The yeasts are perfectly non-affectable towards sugars containing seven or eight atoms of carbon. These latter sugars do not occur in Nature—they have only lately been synthetised by the chemist—so that the yeasts and their ancestors have had no experience of them. The yeasts know nothing of them: they are unable to come into chemical relationship with them. But by "education" the yeasts can be forced to become familiar with them, to attack them—"which things are an allegory." This curious specificity has been explained or rather illustrated by the analogy of a lock-and-key. As there is only one key which fits one Yale lock, so there is only one enzyme which will break down or dissolve one particular kind of substance. The molecular configuration of the pepsine key will not fit into the molecular structure of the starch or sugar lock.

In a certain sense, the discovery of ferments, or at least the acceptance of the doctrine of enzyme-action, has revolutionised biology. It is hardly too much to say that life is synonymous with the power to produce ferments. From the amœba in the stagnant horse-pond up to the "noblest work of God," enzymes are essential to the exhibitions of vitality: the ferments are omnipresent, and, in their own sphere, omnipotent.

It is curious, but true, that such exceedingly different phenomena as the digesting of one's dinner, the making of cheese, the manufacture of wine, the disappearance of the dead, the colour of the delicate corolla of the flower on the sun-lit hills and the "uneffectual fire" of the gleam of the glow-worm in the silence of the night, are alike due to these hidden, mysterious, but none the less real, agents of living matter, the soluble ferments.

QUESTIONED DOCUMENTS.

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

America [illegible] added to the English language many words [illegible] phrases, some of which are particularly hap[illegible] [illegible] others [illegible] euphemistically described [illegible] [illegible]ty.

Among the more picturesque expressions of [illegible] must be included the term "Questioned Documents," which is a useful description of all letters and papers the authenticity of which there is reason to doubt; and the occupation of "Examiner of Questioned Documents" is now a recognised profession in the United States.

Most of the investigations of this nature in America have dealt chiefly with the character of the handwriting, and it is only recently that any degree of attention has been given to the scientific examination of the ink, paper, and so on.

There is, however, one form of fraud which appears to have been more common in America than in this country, and to the detection of which the most scientific methods of examination have been applied. This is the imitation of a signature by means of tracing.

Such an imitation is not always easy to detect, and it requires a careful microscopical examination of the writing to show the irregularities in the flowing of the ink and the want of decision in the strokes which invariably accompany a careful tracing. In some notorious cases the model from which the forger traced his copy has been discovered, and the extremely close correspondence between the two signatures has shown that one of them must have been traced.

An American counsel, in the course of his speech in a trial of this kind, remarked: "It has been said that if a person meet in a waste place three trees growing in a row, he thinks they were so planted by man; should he find the distances equal he is convinced. Such accidental situation of thirty trees would not exceed in strangeness a coincidence like the one in this case."

In this trial, known as the "Sylvia Ann Howland case," in [illegible] evidence was given as to the coincidence of all the letters in the disputed and genuine signatures. Professor Peirce, of Harvard, stated in the witness-box that the probability of all the thirty downward strokes in the two writings coinciding would be one chance in nine hundred and thirty-one quintillions.

I am indebted to the kindness of Mr. A. S. Osborn, of New York, for the details and illustrations of a celebrated trial, in which he gave evidence as to the practical certainty of disputed signatures being tracings.

About ten years ago a man named Rice died in New York at the age of eighty under somewhat suspicious circumstances, leaving an estate worth about five millions of dollars. The day after his death cheques for several hundred thousand dollars, signed with his name, were presented by an attorney named Albert T. Patrick. These cheques being regarded as suspicious, Patrick was arrested and put on trial for the murder of the old man. The jury found him guilty, and he was sentenced to death, though the sentence was afterwards commuted to imprisonment for life.

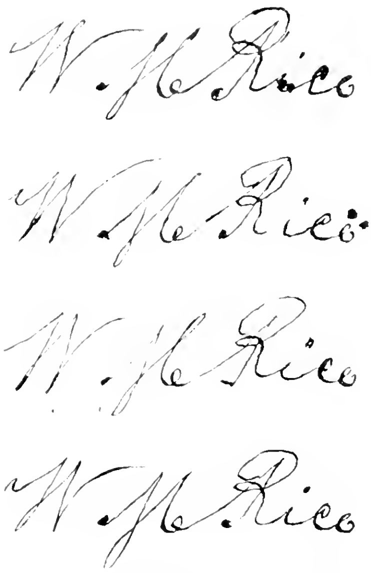


FIGURE 230.
The four disputed Signatures on the Will in the Rice Patrick Case.
Photographed under glass with ruled lines.

After presenting the cheques Patrick had produced a will, according to which the remainder of the estate was made over to him; and his claim was tried in the civil courts, simultaneously with the criminal trial.

This alleged will consisted of four pages, and upon each of these was the signature, "W. M. Rice." All four signatures showed a close correspondence in form, while on the other hand five genuine signatures of Rice, written on the day the will was supposed to have been signed, showed pronounced variations in size, form, and shading, and when photographed under glass with ruled squares did not exhibit the same relative positions for the different parts of the letters. (See Figure 230.) The Court, having had these facts demonstrated to them, pronounced the will a forgery, and the same judgment was unanimously given in two Courts of Appeal to which the case was carried. In the final judgment it was stated that, "Upon a critical examination of the four signatures it will be found that they correspond almost exactly—a correspondence which could not possibly happen in the case of a person upwards of eighty years of age."

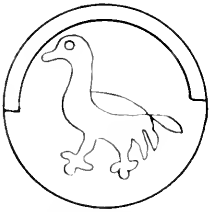


Figure 231.
Early Watermark in Paper.

With regard to this and similar cases it may be remarked that it is not always possible to demonstrate so thoroughly the tracing of a signature, and where there is only one signature involved and the model cannot be found proof must, at best, lack completeness.

Coming now to the question of the nature of the paper of a suspicious document, there are numerous starting places for an examination. Obviously, the watermark will be carefully examined and compared with that in the paper in other documents in the case. An anachronism of the watermark has before now proved that certain writings could not possibly be as old as they were claimed to be.

For instance, forged historical autographs have been detected through having been written upon paper with a watermark of a later period than the alleged date of the writing. The early devices used as watermarks were very characteristic, as may be seen in the accompanying interesting examples, which Dr. Scott has kindly allowed me to reproduce from his book "Historical Documents" (see Figures 231 to 234).

Evidence of this nature was given at a trial some years ago and it was proved that a letter, alleged to have been sent from Venice, had been written upon paper made in England at a later date.

Figure 233.
Early Watermark in Paper.

The evidence of the watermark, however, is not always conclusive as to the date of the paper, since manufacturers may intentionally use moulds of a wrong date. Thus, in a trial which took place in 1834, in Edinburgh, evidence was given by the paper manufacturers that they were post-dating their paper, and were using moulds with watermarks of 1828 pattern to supply a special order. It is only a clumsy forger who will lose sight of the silent testimony of a watermark, but he cannot so easily protect himself against variations in the structure and composition of the paper itself.

In the old type of paper made from rags little differences can be observed in the structure of different samples, which contain more or less disintegrated fibres of cotton or linen, such as are seen in Figure 235, which represents the microscopical appearance of a fragment of eighteenth-century writing-paper.

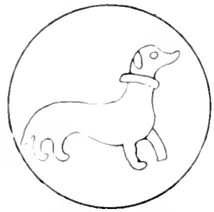


Figure 232.
Early Watermark in Paper.

At the present day paper is made from wood pulp, and all kinds of vegetable fibres, and it is only the more expensive qualities which are still made exclusively from rags.

A specimen of a so-called Manilla writing-paper gave the microscopical appearance shown in Figure 236. For these two drawings I have to thank my friend, Mr. R. M. Prideaux. It is obvious that the production of a piece of writing dated, say, thirty years ago, would probably not be genuine if written on paper with the structure of the second specimen.

But apart from the structure, there are pronounced differences in the amounts of ash and in the nature and quantities of the mineral constituents in the ash of modern samples of paper.

For instance, Levi (*Zeit. angew. Chem.*, 1910, XXIII, 1258) has devised a sensitive method of estimating the amount of sulphur in paper by means of the yellow colour produced on adding alkaline lead acetate to the fused ash. So sensitive is this test that a perceptible yellow coloration was given by an ash containing as little as 0·00000303 gramme of sulphur.

Further valuable tests of the genuineness of a document may be based upon an examination of the sizing.

It has not infrequently happened that a slight erasure has changed the whole sense of a letter.

Figure 234.
Early Watermark in Paper.

An instance of this came within the writer's experience, where a letter containing the words "our house" was put forward as evidence as to the ownership of the property.

When this was examined under the microscope by transmitted light it showed unmistakeable signs of erasure in front of the "our," the sizing having been removed and the fibres scratched up apparently with the point of a knife. The paper was also more transparent at the place where the erasure had taken place.

These facts supported the contention of the other side that the original reading had been "your," and that the "y" had been erased.

To lessen the chance of detection from such a trail, skilful forgers have been known to paint the place over with a resinous solution, so that superficially it has the appearance of the rest of the surface of the paper. This dodge may be detected by an examination of the sizing, the patched place being easily stripped by brushing it over with alcohol, in which the resin will dissolve.

Tests have also been devised for distinguishing between papers sized with material of animal and of vegetable origin. For instance, if a small piece of the paper be soaked in a two per cent. solution of copper sulphate, and then treated with a few drops of a five per cent. solution of potassium hydroxide, a violet coloration (the biuret reaction) is at once obtained if gelatin or casein is present.

In certain cases "Hughes' iodine reaction" may also aid in the differentiation of two kinds of paper. If a strip of paper is moistened with potassium iodide solution and suspended in a place protected from chemical fumes, a gradual liberation of iodine will take place. This appears to be due to the presence of undecomposed alum or aluminium sulphate in the paper, and according to Strachan (*Chem. News*, 1911, CIII, 193), the intensity of the coloration affords a measure of the latent acidity (due to the alum) in the paper. It also gives a probable explanation of the rapid deterioration of certain modern written documents.

Commercial papers differ considerably in their behaviour in this test, and upon its results may be based an approximate estimation of the amount of undecomposed alum present.

Figure 235.
Fibres from Eighteenth Century Paper.

In addition to the ink, the paper, and the writing itself, there are frequently other points about a questioned document which will repay careful examination; for the pitfalls are so numerous that in avoiding one a forger will almost certainly fall into another.

In illustration of this the following amusing case within the writer's experience may be cited: A Jewish family insured their household goods and, in

Figure 236.
Fibres from Modern "Manilla" Writing Paper.

particular, a quantity of valuable jewellery, with one of the leading insurance companies in London. Being thus protected, they soon became the prey of enterprising burglars, and in this unfortunate affair lost all their jewellery, which was valued at about £150.

In the claim presented to the company receipts were produced signed by the jeweller from whom, as they alleged, they had bought the jewellery.

Such claims, when not genuine, are not easy to disprove, although in the present case the insurance company had a strong suspicion that there had been no burglary, but that bogus receipts had been concocted in collusion with the jeweller, who had an address but no shop.

There were in all three receipts, the first made out in December to the eldest daughter, the second in January to the father, and the third, which was dated in February, to the daughter, who had been married since the date on the first receipt.

The paper of the bill-heads of the first and third receipts was of the same kind, and the writing on these was in the same sort of ink, whereas the paper and ink of the second receipt were of a different kind.

The inks upon the first and third bills were of too recent origin to determine whether they were of the same age, although it was significant that they behaved in exactly the same way towards bleaching reagents.

Much more conclusive, however, was the fact that the right hand side of the receipt stamp upon the earlier bill corresponded in every detail with the left hand side of the stamp upon the later bill. Wherever, in tearing the stamps apart, a short projection had been left on the one there was a corresponding long projection upon the other. In fact, throughout the whole of the seventeen projections there was perfect coincidence in every point, as is shown in Figure 237. This agreement could scarcely have been accidental, the chances against such complete correspondence being overwhelming, while it was most improbable that the jeweller should have kept one of two adjacent stamps for three months and have then affixed it to a second receipt given to the same person.

Figure 237.
Coinciding edges of Receipt Stamps.

The only alternative to these conclusions was that the stamps had been put at the same time upon receipted bills dated three months apart. This view appeared convincing to the insurance company, and they refused to meet the claim.

It is perhaps in tracing the authorship of anonymous letters that the circumstantial evidence of overlooked trifles may prove the most valuable.

Of late, such letters have frequently been typewritten, evidently under the mistaken notion that in this way the identity of the writer would be effectually concealed. But, unfortunately for the anonymous letter-writer, each typewriter has its own idiosyncracies, and the differences that may be noted between the letters upon two new machines become much more pronounced with use.

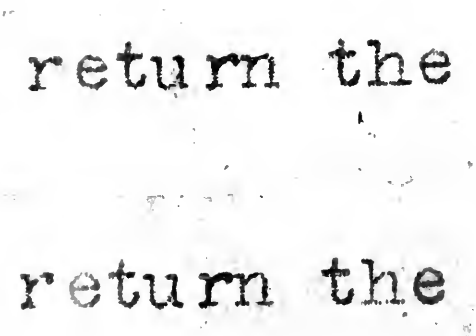


Figure 238.
Typewriting done on the same Machine.

The types become worn and soon get out of alignment, and as the faults of spacing and position repeat themselves or become more accentuated it is not a difficult matter to prove that a letter must have been written upon a particular machine.

Observations made by the writer have shown that letters written upon the same typewriter at intervals of over a year will exhibit corresponding peculiarities.

This is seen in Figure 238, which shows enlarged photographs of typewritten words. These words were part of an anonymous letter received by a clerk, accusing him of having taken a sum of money, and threatening him with exposure if he did not "return the amount."

Suspicion pointed to a certain individual as the sender of the letter, and the suspicion was proved to be well founded by the results obtained on typing the words upon his machine.

On first thoughts it would hardly seem likely that the sealing wax in the seals upon a letter should afford any useful information, but the Fink case proves that the composition of the wax may furnish a strong link in a chain of evidence.

In October of last year, Major Fink was tried at the Old Bailey on the charge of having forged a cheque by altering the amount from £10 to £10,000.

The alteration had been clumsily done, and it was obvious even upon casual inspection that there had been tampering with the words and figures.

The ink in which these alterations had been made was of the same kind as that of Major Fink's endorsement upon the back of the cheque, and as that contained in his fountain pen, while it was of a different kind from the ink in the signatures on the face of the cheque.

The prisoner asserted that the amount of the cheque was only for £10 when he had posted it, and his suggestion was that the letter had been tampered with while in the post.

Now it had been sent to the bank in a registered sealed envelope, and had been followed by a second letter also in a sealed and registered envelope. A stick of red sealing wax was found in the possession of Major Lark, and the question therefore arose whether this wax agreed in composition with the wax in the seals upon the two letters.

The close agreement in the composition of the stick of sealing wax and the seals upon the two letters left little room for doubting the origin of the latter.

Sealing Wax.	Ash. Per cent.	[illegible] Ash. Per cent.	Sulphate in Ash. Per cent.	Resin. Per cent.	Vermilion. Per cent.
Major [illegible] Wax	58·20	16·56	13·14	46·71	32·59
Seal on Letter I.	58·29	16·43	13·44	46·77	32·25
" " II	58·26	16·58	13·58	46·57	—
Commercial Wax I.	57·37	37·67	20·79		present
" " II.	28·66	23·92	3·27		"
" " III.	73·82	73·08	nil.		"
Seal on Parcel	19·64	Trace		—	"
" " Letter	40·40	12·59	10·25		"
Wax from Post Office	50·11	Consisting chiefly of iron oxide. No vermillion.			

TABLE 19. Composition of Sealing Waxes.

At the same time an analysis was made of the wax from the post office where the letters had been posted, and of various other commercial specimens of sealing wax, taken at random, and the results which were obtained are given in Table 19.

After hearing evidence upon this and the other scientific points raised in the case, the jury found the prisoner guilty, but they also concluded from the medical evidence put before them that he was insane at the time he committed the forgery.

THE OLDEST HERBARIUM IN THE WORLD.

By ELEONORA ARMITAGE.

WHEN I found my way to the secluded gallery in the great Museum of Antiquities at Kasr el Nil, in Cairo, where repose what are, I suppose, the most ancient dried plants on the face of the earth, I wondered how many people ever paid them the tribute of a passing inspection! Men come in thousands to wonder at and admire the vast assemblage of human handiwork of bygone ages, gathered from a thousand miles of the Nile Valley, but there seemed to be scarcely one who cared to enter and ponder for a few moments on these works of nature, preserved by the men of Ancient Egypt with care and loving reverence to do honour to the dead, whose earthly tabernacles were to last like these for scores of centuries.

One's memory is recalled to that era of brilliant civilisation and of elaborate development of art which obtained during the Eighteenth and Nineteenth Dynasties, a period between the seventeenth and twelfth centuries before Christ, which is especially associated with the names of Amenhotep, Thothmes, and Queen Hatshepset, and later with those of Seti the First and Rameses the Second, the Great.

For what are we gazing at? Garlands and wreaths from the tombs of these kings. There is no question here of the ancient floras of the earth, which are hewn from time to time from the rocks to rejoice the heart of the palaeo-botanist; these plants are all truly "recent" in the geological sense; but the fact that they are all precisely similar in every detail with their congeners growing in the Nile Valley to this day, proves the antiquity and persistence of certain species of plants. It is interesting to see the ancient and modern specimens mounted side by side in the cases to invite comparison.

The long wreaths taken from the mummy cases of Aahmes I and Amenhotep I were elaborately and beautifully made. To a strong foundation of palm-leaf fibre were tied a close succession of split and folded leaves of the Mimusops Tree, large oval leaves tied with narrow thongs of palm fibre, while within each leaf was placed a petal of the Blue Water Lily, the Lotus of the Nile. It is astonishing to see how well these petals, now brown or white, are preserved. Other wreaths had a foundation of Willow leaves between which were the fragile petals of a Hollyhock, or blue Larkspur flowers were used, while sometimes in addition we find the sweet-scented yellow balls of the Nile Acacia, the Sunt. Some of the wreaths investing the mummy of Rameses II when it was found at Der el Bahari had been renewed by the pious care of some Twentieth Dynasty ruler, and were composed of Mimusops and of another species of Lotus. There were floral neck-wreaths, too; one made of wild celery leaves all smoothly pressed out, another of malt, the germinated barley with a thick tangle of rootlets; besides which are found branches of Olive, of the Sycamore Fig, and leaves of the creeping desert Gourd, the Colocynth, and several other flowers. Numbers of seeds of this period have been found, chiefly of cereals, legumes or forage plants, just the same kinds which are still grown by the industrious fellahin on the irrigated land.

Before we leave the gallery we must glance at the portraits in colour of several of the native Nile plants which we see on the walls. These come from the palace of the well-known heretical king, Akhenaten, of the Eighteenth Dynasty, who, deserting the ancient worship of the Sun God for that of the Solar Disk, left Thebes to build a new capital at Tel el Amarna. Needless to say his successor returned to the old faith and the old city; but here we see how the floors of reception halls in royal palaces four thousand years ago were decorated. The stucco pavements were painted over with designs of water with aquatic birds and beasts amid clumps of vegetation, reeds and grasses, the colouring being green, red and blue on a white ground. Here one recognises red and blue Lotus flowers, there waving Reeds and Papyrus, blue-headed Thistles, Scarlet Poppies and trails of Convolvulus, all depicted with exact yet conventional accuracy.

Who is there that has voyaged to the upper Nile and has not seen the water, and the stretches of vegetation and the birds and the beasts, and may not yet see the Chieftainess of Thebes, the Sacred Cow of Hathor, pushing her way through the Papyrus brakes and Nile Lotus, even as she is depicted on her statue which came from Der el Bahari? Egypt is very old—and yet she *is*.

SOME PRIMITIVE BRITISH INSECTS.

I.—THE PROTURA.

By RICHARD S. BAGNALL, F.L.S., F.E.S.

AN insect without antennae!

It was on the occasion of a field meeting of the Northumberland, Durham and Newcastle-upon-Tyne Natural History Society, at Mitford, Northumberland, in the May of 1909, I first met with this curious form of insect life. I remember I was searching for those tiny, bustling centipedes, the Pauropods, at the time. Under a log lying by the roadside was a colony of *Pauropus*—of a species then unrecorded as British—and with it were two small creatures, yellowish and to all appearances larval. But under a lens they presented an altogether strange appearance, chiefly on account of their conical beak-shaped heads, and of the great development of the fore-legs, the peculiar posture thereof reminding one of the Praying Mantis. I therefore bottled them, and placing them under the microscope at home I discovered other peculiarities no less striking.

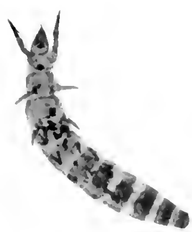


FIGURE 239. FIGURE 240.

Accerentomon affinis Bagn., enlarged. The natural size is 1·6 mm.

The mouth parts were quite unlike those of any other insect known to me; eyes, antennae and wings were absent; the claws were similar to those of the bristle-tails (Thysanura), the last abdominal segments reminded one curiously of a crustacean, and there were no spiracles. Several structural features, including the genitalia, proved that the insect was not larval.

I felt that I had thus stumbled upon an entirely new type of insect, and as such labelled my preparation, but lack of knowledge and literature together with the pressure of other interests and important work, forced me to put it to one side.

It is curious how strange occurrences such as this revolve in one's mind. Without antennae, eyes and wings! We can bring to mind whole orders of wingless insects, such as the springtails (Collembola), bristle-tails (Thysanura), bloodsucking and biting lice (Anoplura and Mallophaga) and numerous sightless arthropods. But without antennae, or in other words, without either of the organs of sense, the eyes and antennae! This curious creature was brought before me more forcibly by the discovery of a second species in 1910, a third in August and yet another in December, 1911, the latter in profusion, and whilst recently corresponding with Professor Filipo Silvestri on other matters, I sent him a rough sketch and asked his opinion. He informed me that these insects were, as I had thought, true insects, and that they belonged to the order Protura, an order diagnosed by him as recently as December, 1907.

Thus ended my dream of the first discovery of an entirely new type of insect!

Its history is, however, a short one; the insect is known to very few naturalists, and yet about a dozen species have been described, mostly by Berlese from Italy, who, in 1909, monographed the order in his usual most thorough and comprehensive manner.

FIGURE 241.

The anterior end of *Accerentomon*, greatly enlarged.

Accerentomon—"An insect without antennae," that is the literal translation of the name proposed by Silvestri. ἀ=without; κέρας=antenna; ἔντομον=insect. Could a more appropriate name be chosen?

The position of the front pair of legs suggested to me that they, in a measure, protected the head. I recently had the opportunity of watching the living insects, and it was especially interesting to note that the long front legs were not used to any extent for walking, but as feelers held tremulously on each side of the head, and this observation is confirmed on examination of the fore-tibia under a high power, when sense-organs similar to those found on the antennae of many insects can be clearly seen.

The known species fall into two families, the representatives of one family, Acerentomidae (containing most of the species), are without stigmata; those of the second family, Eosentomidae possess a complete tracheal system and two pairs of stigmata on the meso- and metathorax respectively. All species possess three pairs of abdominal appendages, one on each of the first three segments of the abdomen, but in the Acerentomidae the second and third pairs are vestigial, whilst in the other family they are all similarly well-developed and distinctly two-jointed. These are the abdominal feet (*pedes abdominales*) of Berlese.

The first family is composed of two genera, *Acerentomon* and *Accerentulus*, the former being characterized by the beak-like prolongation of the upper labrum; the second family contains but a single genus, *Eosentomon*. Both families (and the three genera) are represented in my English material, but with the exception of a species of *Acerentomon*, which I propose to name *Acerentomon affinis* on account of its close relationship to *Acerentomon doderoi* Silvestri,* the type of the order, and which occurs under the bark of an old elm log in Gibside in considerable profusion and in the Wear Valley, my material is not well-preserved. A minute new species of *Eosentomon* occurs very sparingly in a quarry near my home at Penshaw, County Durham, together with a recently-described Pauropod (*Brachypauropus lubbocki* Bagnall).

Anyone familiar with the haunts of *Pauropus* will in all probability become acquainted with the *Protura*, perhaps the most primitive and bizarre of insects.

* My examples have been examined by Silvestri, who considers that they are not referable to his *A. doderoi*.

SOLAR DISTURBANCES DURING APRIL, 1912.

By FRANK C. DENNETT.

DURING April only nine days—7th, 19th, 20th, and 22nd to 27th—are registered as without solar disturbance. On twelve others only faculae were observed. The longitude of the central meridian at noon on the 1st was 38° 11′.

On the 2nd a pale faculic knot was seen at longitude 80°, S. latitude 22°, and another near longitude 326° in high southern latitude. Close to the eastern limb, latitude 11° to 13° South, a bright disturbance showed, which was better seen on the 3rd and 4th when it contained a bright horseshoe-shaped form. It was double, one from 287° to 293° and extending to 310°. These were not so well seen on the 5th and 6th, when farther advanced upon the disc. On the latter date two other faculae were visible around longitude 261°, S. latitude 10°, and 48°, 19° S. On the 9th a knot was seen in S. latitude near longitude 5°. On the 12th there was a pale faculic area around longitude 183°, in 7° S. latitude. On the 14th a pale facula was situated around longitude 297°, in 50° N. latitude. On the 15th the faculae behind the spot group were visible within the western limb. There appeared to be faculic disturbance around longitude 202° in N. latitude 50° on the 16th. On the 17th, several small flecks of brightness were noted scattered about the disc, but none were measured. On the 18th, a pale faculic disturbance was situated near the equator about longitude 108°. On the 21st there was a pale facula near longitude 54°, N. latitude 3°. On the 28th, 29th and 30th the faculic disturbance from 295° to 324°, in S. latitude 4° to 17° was within the eastern limb.

No. 2.—A small pore about two days past the central meridian on April 1st, and about which minute companions showed at times. Its position, only seen on one day, is kindly communicated by the Astronomer-Royal.

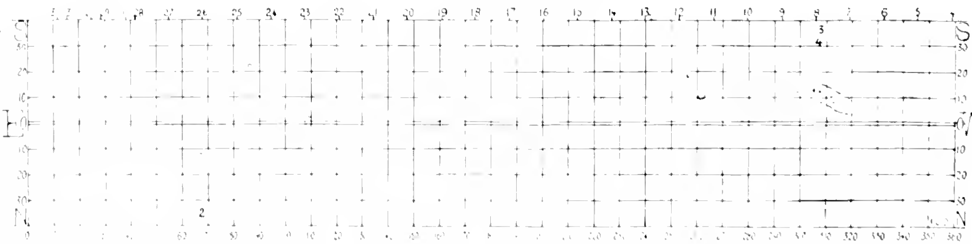
No. 3.—When the faculic area, conspicuous within the eastern limb early in the month, reached the middle of the disc, on the 8th, a line of penumbraless pores developed with bright lips, over 42,000 miles in length, but very soon new pores ahead increased the length to 82,000 miles. On the 9th there was a curve of pores 112,000 miles in length. During the day an ellipse of fourteen spotlets opened within the curve; the outliers soon died out. The rear spotlet increased to 15,000 miles in diameter by the 10th, and a penumbral mass with at least four umbrae formed in front, which for a little while was 21,000 miles in length. During the 11th part of the middle of the group faded away, but it was still a conspicuous object as it neared the western limb on the 14th. The figure on the chart was that of April 9th.

No. 4.—Was a spotlet with about three umbrae amid the faculae within the eastern limb on 30th, other pores south and west were seen on May 1st. On the 2nd a little group of pores, 29,000 miles by 22,000 miles, was seen. There were other changes noted on the 3rd, 4th, and 6th, but it was not seen on the 5th, and on the 8th only a solitary pore was visible apparently just west of the place of the group, but it had gone on the 9th.

On the day of the Eclipse there were no striking disturbances on the disc, and the weather was all that could be desired. There were some interesting prominences upon the limb, which were first covered and then uncovered by the advancing moon. Beyond the cusps of the crescent in the middle of the eclipse the chromospheric lines stood out beautifully in the spectrum. About the same time three separate observers for a short time thought the lunar limb appeared projected upon the corona, but each fancied the appearance might be due to an optical illusion.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, W. H. Izzard, D. Booth, and the writer.

DAY OF APRIL, 1912.



THE ULTRA-MICROSCOPE AND ITS APPLICATION TO THE STUDY OF COLLOIDS.

By E. JOBLING.

It is often imagined, by those unacquainted with either of the sciences of light and microscopy, that it is merely a question of difficulties in construction of the microscope, particularly of the lenses employed, which prevents us from perceiving the very smallest of objects by its aid. Such, however, is not the case. At certain definite limits of size, phenomena intervene which effectually mar every effort at the microscoping of objects with diameter below this limit. The root of the difficulty lies in the phenomenon of light itself. The fact that light is a transverse vibration of appreciable wave length is of slight importance when dealing with the common objects of everyday experience, but immediately the attention is turned to objects of size comparable with this wave length, the mechanism of light propagation assumes tremendous significance. Then it is that the ordinary laws of reflection and refraction are waived in favour of the more subtle, and therefore the more interesting, phenomena of diffraction.

On the commonsense principle that a sea-wave is but little disturbed by a pebble, though profoundly modified when brought up against a sea-wall, it seems reasonable to assert, without further explanation, that an object comparable in size with a wave-length of light cannot be expected to reflect waves which could convey to the eye a distinct impression of its size and shape. True, it does affect a minute disturbance, but of this more anon. Without venturing into a mathematical discussion of a microscope's "resolving power," it will be sufficient to state that one cannot hope to perceive an object whose size lies below one quarter of a wavelength of light, this constituting the limit above referred to.

However, fortunately or unfortunately, scientists have interest in objects much smaller than these. Thus, the ever-increasing subject of colloids demanded an instrument for the direct observation of colloidal particles; and bacteriology, again, found itself hampered for want of a means of visualising the cells and microbes with which it is concerned. The difficulty has been happily surmounted by the introduction of the ultramicroscope, an instrument which, as its name implies, renders it possible to demonstrate to the eye the existence of objects invisible ordinarily to the finest microscope.

This does not imply that the ideas put forward as to the limits of optical resolution have been in the least contradicted, as the following consideration will show. To be seen, an object must either reflect the light by which we see it or be self-luminous. Consider only a very small particle. If it be of a magnitude above the optical limit, it may be seen by virtue of the light it reflects, and its true form can then be perceived. If, however, its magnitude is below this limit, reflection is impossible, and all incident light becomes diffracted, *i.e.*, scattered in all directions. In the latter case, the object emits light exactly as though it were luminous of itself, though under ordinary circumstances it remains invisible because the proportion of light reaching the eye with regard to the incident light is so small. If now means be adopted for concentrating light upon the object, it might be possible, other circumstances being favourable, to make it emit sufficient light to reach visibility. Of course, the object then cannot be seen in the sense that its shape or surface can be observed, but only seen in the sense that its presence is indicated by the light it emits, being observed in the microscope as a minute disc of light. The utilisation of such a concentrated illumination is the fundamental idea underlying the construction of the ultramicroscope.

This principle was foreshadowed by a phenomenon observed long ago by Tyndall, who passed an intense beam of light through the air of an otherwise darkened chamber, when the track of light was made clearly visible by the light diffracted from the minute dust-motes floating in the atmosphere. Ultra-microscopy furnishes an extension of this, a microscope being introduced for the fuller examination of the track of light. Thus, Zsigmondy, in 1900, as part of his observations on some colloidal gold solutions, reflected a cone of light into the solution and examined the apex of the cone through a microscope. Working on the same principle, Siedentopf was led in 1903 to the improvement of the apparatus, with the result that we owe to him the introduction of the modern high-power illuminating arrangements which form the main feature of the instrument.

Naturally, certain conditions require to be fulfilled. In the first place, the most intense illumination possible is necessary to render the smaller particles visible; secondly, to prevent dazzling of the eye and consequent inability to detect the minute light-discs, no illuminating ray must be allowed to fall upon the eye either directly or by reflection; thirdly, in view of the often extreme faintness of the light-discs, the darkest possible background is essential; and lastly, the beam of light must be extremely shallow in the direction of the line of sight, else nothing more definite would be observed than a luminous haze. Only by rigid satisfaction of these conditions can definite results be obtained.

In the light of the above requirements, the following diagrammatic arrangement of the apparatus constituting one of the most delicate forms of the ultra-

[ultra]microscope ... shown in Figure 242, shall be considered. The sun's rays are reflected from a heliostat through the slit A into the darkened laboratory in which the apparatus is set up. The light is then ... to B, a telescope objective, by which it is concentrated on to the slit C, which is capable of very fine adjustment. D is a screen

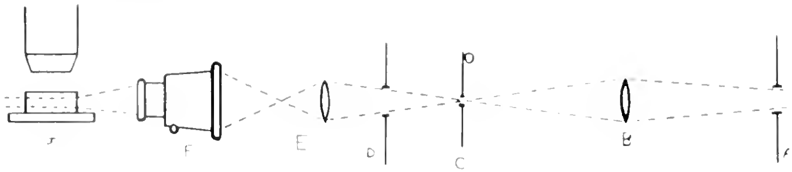


FIGURE 242.

with an aperture of sufficient size to cut off any stray rays of light reflected from the edges of the slit. Another objective, E, directs the light into the condenser F, from which it passes as an intense beam into the solution contained in G. At right angles to the path of light is arranged the microscope H for minute examination of the track of light in G. This latter cell, for the use of solutions, usually takes the form shown in Figure 243, the rectangular part K having quartz faces and being fitted also with a funnel and outlet, which permit of easy washing and filling without disturbing the adjustment.

The above design by Siedentopf of the ultramicroscope is not the only one which has been used. A simpler device, due to Cotton and Mouton, is worthy of note. An oblique parallelopiped of glass, surmounted by the solution and cover slip, is placed upon the stand of the microscope. The convergent illuminating beam follows the course shown in Figure 244, the angle of incidence on the upper surface being adjusted to lie between the critical angles for water-glass and glass-air surfaces and the beam, therefore, is totally reflected. Then, the only light which enters the microscope H is that diffracted by the ultramicroscopic particles of the solution.

For the examination of larger particles, e.g., cells, bacteria, and so on, modified forms of the apparatus may be employed, in which, for convenience, the illuminating rays and the rays diffracted from the particles are in the same straight line. But as these would require complicated designs and descriptions, their consideration is omitted.

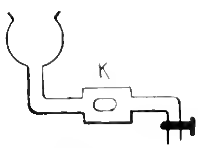


FIGURE 243.

To understand at all completely the beauty of this apparatus, resort must be made to a consideration of several of its more interesting applications. Its possible service to the colloidal chemist and to the bacteriologist has already been hinted at, and we cannot do better than turn our attention to at least one of these applications. Before so doing, a few

words indicating the degree of sensitiveness as compared with other methods of analysis might be deemed interesting. By the aid of spectrum analysis, Bunsen and Kirchhoff consider that $0\cdot14\times10^{-[illegible]}$ mg. of sodium can be detected; whilst, in the case of hydrogen, Emich avers that as minute a quantity as $0\cdot7\times10^{-[illegible]}$ mg. gives appreciable indication of its presence. Again, it is asserted by Fischer that by the sense of smell $2\cdot2\times10^{-[illegible]}$ mg. of mercaptan and by Berthelot that 10^{-11} mg. of iodoform are capable of detection, though here the examples are far and away among the most exceptional that could have been chosen. In the chemical way, too, 5×10^{-7} mg. of sodium hydroxide are able to produce a definite change in the colour of some suitable indicator. With the ultramicroscope, however, a particle of gold of mass 10^{-15} mg. in a gold ruby glass may be observed without trouble, whilst when the most favourable conditions are available, a particle of size ten times that of an average chemical molecule will not escape observation. Obviously, the potentialities of the instrument are great and there is no saying what more astounding results may be expected when the method is still further improved.

APPLICATION TO THE STUDY OF COLLOIDS.

No more fascinating field of enquiry is open to science than the investigation of so-called colloidal solutions. That such a substance as platinum, for instance, generally regarded as insoluble in water, should be capable of forming what appears to be a solution, is certainly striking on first acquaintance. Not only metals, however, but many "insoluble" substances, like silver chloride, can be made to develop this peculiar state by suitable methods. Natural colloids are of universal distribution, the very constituents of living cells appearing to exist in such a form. The properties of a colloidal solution afford a striking contrast to those of ordinary solutions; for instance, their slight ability to diffuse and consequent separation from truly soluble salts by dialysis, their insignificant osmotic pressure, their peculiar electrical properties which seem to point to the presence of an electric charge upon the particles, their capacity for coagulation and absorption, and so on. All these circumstances add an interest to the study of colloids which has served to attract a great host of investigators, as will be gathered from the enormous output of work upon the subject.

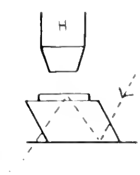


FIGURE 244.

Much controversy has been waged over the exact nature of these colloidal solutions, for they bear intimately upon the problem of solution in general. Many investigators have been inclined to the idea that they represent perfect solutions, whilst others identify them as suspensions. The intervention of the ultramicroscope has contributed largely to the development of the question, if not to its final solution.

With one or two exceptions, all colloidal solutions on ultramicroscopic examination are found to contain distinct particles, which reveal themselves, as already stated, in diffraction-patches on a grey background. These particles can be counted and their size calculated. There is thus strong evidence for regarding a colloidal solution as merely a limiting case of a suspension. A crystalloidal solution, *i.e.*, the solution of a substance like sodium chloride, gives an absolutely clear field, and one, therefore, infers the absence of even the tiniest particles in a solution of this type. Such a conclusion, however, is questioned by the observations of van Calcar and de Bruyn, who found, for example, that rapid centrifugalisation of a sodium sulphate solution induced partial separation of the salt. From the above reasoning, and further observation but confirms this, it seems impossible to draw any sharp line of demarcation between suspensions, colloidal and crystalloidal solutions, the one class merging imperceptibly into the other. Ultramicroscopic study shows over how wide a range the size of the particles in a colloidal solution varies and renders any attempt at classification of solutions still more unsatisfactory. Indeed, it seems probable that in a solution the size of the "dissolved" particle can vary gradually from that of the ordinary chemical molecule to the dimensions of a visible suspensoid particle, the properties of the resulting solutions varying with the molecular forces called into play.

But more interesting developments even than these can be attributed to the ultramicroscope, for results recently obtained by its aid go far towards strengthening the probability of the Atomic and Molecular Theories. Over a century ago, the naturalist Brown observed that the particles of a fine suspension, when observed under the microscope, are in a continual state of agitation, but the observation was shelved and almost forgotten. It is only in recent years, and mainly by the application of the ultramicroscope, that the further investigation of this interesting phenomenon has been rendered possible.

The ultramicroscope has demonstrated that the smaller the particle the greater the activity, until in colloidal solutions we get a movement so violent as to resemble, in the words of Zsigmondy, "a swarm of dancing gnats." There seems to be some connection between this rapid movement of small bodies and the slower movement of the heavier particles observed by Brown. Indeed, it almost suggests that, if further diminution of the particles be imagined, the attainment of molecular dimensions might give a value for the molecular velocity of an order comparable with that calculated on the theoretical assumptions of the Kinetic Theory: in other words, that the kinetic energies of a molecule and of a colloid or suspensoid particle are equal. This view has developed almost into a certainty, particularly by Perrin's remarkable investigations, and an experimental verification of the Kinetic Theory is thus forthcoming.

A brief outline of Perrin's work will serve not only as a development of the above brilliant idea, but also as a fitting demonstration of the methods employed in ultramicroscopic research.

In the first place, his investigations required a colloidal solution, the particles of which were of the same size, and this was rendered possible by the method of "fractional" centrifugalisation. The uniform solution, after dilution and standing for some time, was then examined ultramicroscopically, the microscope being focussed on an extremely shallow beam of light capable of vertical movement. At positions corresponding to different heights of the solution, an estimate of the number of particles was accurately made. This, of itself, is an extremely laborious undertaking. The particles illumined by the beam are visible in the field of the microscope, but are executing their Brownian dance, and it is impossible to make even an approximate computation of their number. The difficulty is overcome by the use of one of two methods. Either the field of view is instantaneously photographed several times and the mean number taken; or a stop is inserted in the microscope so as to limit the field to contain only a few particles, and then, by means of a shutter, instantaneous "peeps" are obtained at small intervals, the number of observed particles being noted at a glance, and subsequently the mean of several thousand of these readings taken. Both methods give very concordant results. Having ascertained the number of particles corresponding to different heights in the solution, examination showed that these were, within the limits of experimental accuracy, exactly in geometrical progression.

Thus, at heights 100 75 50 25 microns,
the numbers 200 170 146 116 were obtained,
whilst 201 169 142 119 are in exact

geometrical progression. Such results demonstrated beyond doubt that the particles reach a state of equilibrium where their distribution corresponds to that of the molecules of a fluid. Thus, in the atmosphere, the concentration of the constituents gradually diminishes as we ascend, the diminution obeying the above exponential law. The only difference between the two cases is that whilst the atmosphere requires a rise of six kilometres for the halving of the concentration, a colloidal solution requires about one-tenth of a millimetre.

Having proved that such an experimental law was applicable to colloidal solutions, a mathematical expression was easily deduced by which, given the density of a particle, its mass and the number per unit volume, the Kinetic Theory constant (which denotes the number of molecules per gram-molecule of any compound) is calculable. For the present purpose it is not necessary to go into the mathematics

Of the [illegible] sufficient that the [illegible] the air-pressure which prevent [illegible] [illegible] the [illegible] and [illegible] deduced [illegible] the application of Stokes' law which gives an expression for the velocity of a sphere as it sinks through a viscous fluid. The velocity of fall of colloidal particles in a capillary tube, as they descended to take up their final distribution, was carefully observed and by substitution in Stoke's equation the mass of the particles calculated.

Everything is now ready for the determination of the Kinetic Theory constant. On the basis of this theory, the constant has been worked out to be 7×10^{-23}. Judge of the interest and importance of the above investigation, absolutely experimental throughout, when the value of the constant was found to be $6{\cdot}9 \times 10^{-23}$. Since then, more accurate determinations have been made and it seems that the above method comprises a means for the determination of that fundamental constant, the number of molecules per gram-molecule, which is capable of almost unlimited precision. The gas-laws, already applied by van't Hoff to dilute solutions, are thus extended by Perrin to uniform emulsions. In addition, his researches form no mean part of the evidence which has lifted the "molecule" out of hypothesis into reality.

Enough has been said to indicate the wide scope of application of the ultramicroscope, and there is every reason to believe that this scope will be considerably extended in the near future. Even now we hear of such developments as the cinematographing of the particles visible by its aid, particularly blood-corpuscles and attendant disease-germs. Certainly it is to this apparatus that we look for further information regarding the nature of protoplasm and the problem of living matter, it being reserved for future reviewers to say whether or no these expectations have been realised.

CORRESPONDENCE.

ON THE RESEMBLANCE OF THE FLORA AND FAUNA OF IRELAND TO THAT OF THE SPANISH PENINSULA.

To the Editors of "KNOWLEDGE."

SIRS,—In the very interesting article by Dr. Scharff in the March number of "KNOWLEDGE," he mentions that the beetle, *Rhopalomesites tardyi*, occurs only in the south-west of England. It may perhaps interest some of your readers to know that I have taken it in some numbers in the neighbourhood of Hastings. It occurred in an old holly hedge which had been cut back repeatedly, apparently for many years. This hedge was perhaps twenty yards long, and the old stumps were full of the burrows. I am under the impression that the perfect insects occurred only in the branches which had been topped two years before, but of this I am not sure. A row of holly trees which had been allowed to grow unchecked a few yards further on yielded no specimens, though carefully searched. The same is true of many other holly hedges that I searched in vain in the district. The specimens varied very much in size, but the largest was less than half the size of Irish specimens that I have seen.

WM. WILLS ESAM, B.A.

THE SPECTROSCOPIC ASPECT OF IMPACT THEORY.

To the Editors of "KNOWLEDGE."

SIRS,—I was very pleased with Mr. Rattety for his extremely clear statements of the many difficulties in the way of a full detailed interpretation of the spectra of novae. I wish also to thank him for showing so clearly how remarkably the theory of the third body explains all the generic peculiarities.

There are so many chemical and physical agencies at work that the spectrum lines of the first elements will hardly be likely to show speeds corresponding to the law of Graham. Immediately after the impact the molecular speeds will be all alike; hence we have to remember that the temperatures given at collision by the conversion of molar into molecular motion is inversely as the atomic weights. These great differences can only be partially equalised. We have also to remember that in the first state of a third body, the light gases are at the centre—exactly opposite to that of an ordinary star—and that the centre must be enormously cooler than the surface.

The spindle form of the third body would have atomic weights from one to ten at centre; from ten to forty at outside and from forty to eighty at its ends. The escaping gases from the centre will lower the temperature of the elements on the outside, but not of the ends; hence iron, titanian, and so on, may actually show a higher velocity than sodium or potassium, and, as the brilliant nucleus will not generally be shining through the ends, the iron lines will show no reversal on the edge towards the violet. All the deductions have not been able to be observed. But every portion and every characteristic that can be observed correspond. The correspondences are so numerous and so singular, so abnormal, as absolutely to demonstrate the fact that Nova Persei was certainly a third star struck from grazing suns. It is satisfactory to know that an astronomer of repute at the last meeting of the Royal Astronomical Society said "that he thought that Professor Bickerton's conclusions were sound and that the very sudden flare-up of novae indicated the collision of two tolerably condensed bodies."

HYDE PARK, W. A. W. BICKERTON.

THE MECHANISM AND USE OF THE APOPHYSES OF THE SCALES OF THE CONES OF THE SCOTS PINE.

To the Editors of "KNOWLEDGE."

SIRS,—The thick tip of the apophyses is covered with hardened resin, but the broad thick part below the tip consists of spongy cork-cells with several vascular cords running through it. The outer surface is striated, and water readily penetrates it and saturates the spongy cork.

The inner side of the scale tapering to the base consists of a compact layer of thick-walled fibres with a wavy outline.

If the apophyses only be kept in water they soon become saturated; on the other hand, the fibrous layer will presumably tend to contract by shortening the fibres. At all events, the result is that the scales of a cone, in which they are widely spread out, now all contract and the cone closes up tight.

We thus see why, after fertilisation of the ovules, the apophyses of the green scales, filled with sap, close up and protect the developing ovules. After all, the moisture has been utilised for the ovules, presumably carried down by the vascular cords penetrating the corky tissue of the apophyses. Then the scales expand, being dried up, and the now ripe seeds are liberated. When the cone finally falls to the ground all the scales are spread out, but if the soil be wet the apophyses re-absorb moisture, and the scales close up again.

GEO. HENSLOW.

HOW TO MAKE STEREOSCOPIC STAR CHARTS.

By A. H. STUART, B.Sc., F.R.A.S.

A FEW years ago, an American firm placed upon the market a series of star charts arranged as stereoscopic slides, so that in the stereoscope they present the very beautiful appearance of shewing the stars in relief. Very few of these slides seem to have found their way into England. Much instructive pleasure may be derived by preparing these slides for oneself. For this purpose we must be able to determine the position of the stars as they appear to

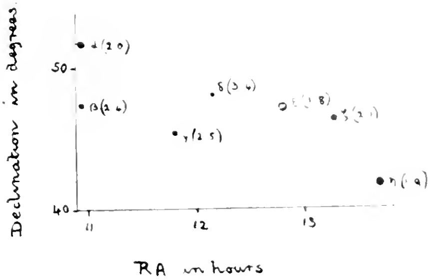


FIGURE 245.

us, and we must also have some knowledge of their relative distance from us. The first of these requirements is supplied by a knowledge of the star's right ascension and declination, which may be taken from the *Nautical Almanac* or similar publication. The relative distance of the stars would be best given by their parallax, but as the vast majority of stars are too remote to shew any parallax, their relative distances have to be estimated by a consideration of their type, magnitude, and so on.

The method of preparing a slide will be best demonstrated by taking a concrete example. Suppose we take the constellation *Ursa Major*, using the magnitude only as an indication of distance. Table 20 is prepared by consulting *The Nautical Almanac*.

It will be wise, at any rate for the beginner, to make a preliminary diagram similar to that shewn in Figure 245. Trouble is saved if this operation is performed on squared paper. The vertical scale is one of declination and the horizontal one shews the right ascension. These two scales must be so proportioned that the diagram shews the stars in the same relative positions as they appear in the heavens. Now right ascension is, of course, given in hours, while declination is given in degrees, and as twenty-four hours are equivalent to three hundred and sixty degrees, we have one hour of right ascension equivalent to fifteen degrees of declination. This, however, is only true at the equator, the great hour circles converging as we approach the poles. It is easy to see that the distance between a pair of these circles at any place compared with the distance measured along the equator is proportional to the cosine of the declination. If the constellation we are plotting is not too large, we may take the cosine of the mean declination

URSA MAJOR.

Designation.		Magnitude.		Right Ascension.		Declination.
[illegible]	...	2·4	...	10h 56m	...	56° 52'
[illegible]	...	2·0	...	10 58	...	62 14
[illegible]	...	2·5	...	11 48	...	54 11
[illegible]	...	3·4	...	12 10	...	57 32
[illegible]	...	1·8	...	12 49	...	56 27
[illegible]	...	2·1	...	13 20	...	55 23
[illegible]	...	1·9	...	13 43	...	49 45

TABLE 20.

for our adjustment without introducing any sensible error. Now the mean declination of the stars in *Ursa Major* is about 50°, and cos. 50 = ·643. Suppose we decide to represent one degree of declination by a distance of two millimetres, then at the equator one hour of R.A. would have to be represented by 2 × 15 = 30 millimetres. But at the declination of *Ursa Major* this distance becomes 30 × ·643 = 19·3 millimetres. Thus Figure 245 is drawn using a scale of two centimetres to 10° of declination, and 1·93 centimetres to one hour of R.A.

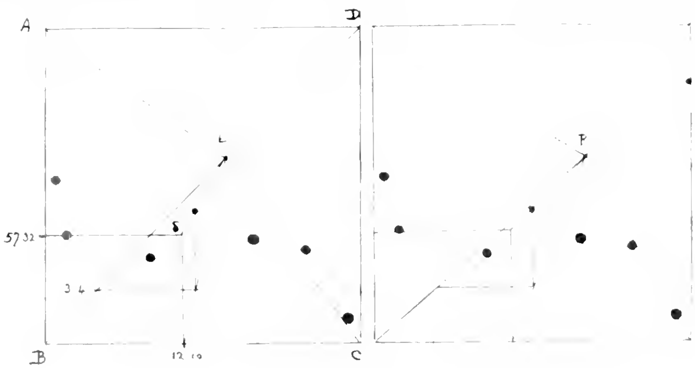


FIGURE 246.

Having settled this matter, the next thing is to prepare the diagram shown in Figure 246. This consists of two squares drawn close together and whose sides are sufficiently long to take the scales of declination and R.A. In these squares are constructed the two views which go to form the stereoscopic slide. Now we have to consider the matter in three dimensions and the squares represent the two dimensions in the plane of the paper. The third dimension, at right angles to the plane of the paper, must now be represented. To do this select a point about the middle of the left-hand square, which will be the vanishing point of all the lines in that square running at right angles to the plane of the paper. To fix the corresponding point in the other square draw a horizontal line through this point and measure along it towards the right-hand figure a distance equal to the distance between the two eyes (about three inches); this will be the required point. These points are lettered L and R in Figure 246 because L is the vanishing point for the view obtained by the left eye and R that for the right eye. The four corners of the square should now be joined to the corresponding vanishing point. It will be well to examine the drawing in a stereoscope at this stage to make sure that all is right. The view obtained should have the appearance of looking down a very long square tunnel. None of the lines should appear double. We will now consider the construction about the left-hand figure only, it being understood that a similar construction on the right-hand figure is necessary. Along the line BL a scale must be made to indicate depth in the figure. In our case this must correspond to stellar magnitude. It is wise to make this scale short compared with the length BL. The graduations on this scale must in each diagram be proportional to the cosine of the angle corresponding to LBC. A simple method of securing this is to drop a perpendicular from C on to the line BL and take a portion of the distance from B to the foot of the perpendicular, and divide it into a suitable number of equal parts. In Figure 246 one-third of this distance was taken and divided into eight equal parts. The point B then represented the graduation for magnitude 1·8, and each subsequent graduation indicated an increase of ·2 in magnitude. It must be clearly understood that this scale in the left-hand figure will be different from that in the right-hand figure; each scale must be constructed independently.

The position of each star in Figure 246 has been fixed by the same method, but in order to make the matter more clear, the construction for fixing the position of one star only (*viz.*, *δ Ursae Majoris*) is shewn. For convenience of reference we will call the line BC (along which the scale of R.A. is made) the axis of x, and the line BA (along which the scale of declination is made) the axis of y. The line BL, on which we have our magnitude scale, we will call the axis of z. First fix the position of the star, as it appears in Figure 245, by drawing a line from declination $= 57° 32'$ parallel to the axis of x, until it meets the line drawn from R.A.$=12^h\ 10^m$ parallel to the axis of y. Call this point δ. From the point on the axis of z, corresponding to magnitude 3·4, draw a line parallel to the axis of x until it meets the line running from point R.A.$=12^h\ 10^m$ to L. From this point of intersection draw a line parallel to the axis of y, until it meets the line running from δ to L. This last point is the position of the star in the diagram. It will be remembered that we took the point B, on the axis of z, as representing magnitude 1·8, which is that of *ε Ursae Majoris*, the brightest star in the constellation. The fixing of the position of this star in the diagram is particularly easy, as it requires no reference to the axis of z at all. A very little practice is sufficient to enable one to make these slides with great ease and rapidity.

It is a great advantage if the construction is done on drawing paper, and the final positions of the stars pricked through on to the final slide, which then shews none of the construction lines. The slides present a much more attractive appearance if they are of black paper, and the position of the stars marked by spots of Chinese white.

NOTICES.

THE ARGENTINE METEOROLOGICAL OFFICE. In an article which the Director, Mr. Walter G. Davis, has contributed to *Symons's Meteorological Magazine* for April, we learn that the Meteorological Service in the Argentine Republic was established in the year 1872. At the present time it consists of thirty-five stations of the first order, equipped with self-registering instruments; one hundred and fifty-six of the second order, where observations are made at 8 a.m., 2 p.m., and 8 p.m.; ten of the third order similar to the second but without barometer, and one thousand six hundred rain gauge stations.

THE TITANOTHERES.—The front page of *The Scientific American* for April 6th, 1912, is occupied by a photograph of the restored head of the largest of the Titanotheres—giant-horned monsters allied to the Rhinoceroses. Some of the animals averaged eight feet high at the shoulder, and sixteen feet in length. For comparison there is also shown in the picture a restored head of an ancestral member of the family, quite hornless, and about the size of the smallest Shetland pony. The heads form part of an exhibit which is being installed in the hall of Vertebrate Palaeontology, in the Museum of Natural History, New York.

BEHAVIOUR OF METALLIC ALLOYS WHEN HEATED IN A VACUUM. *The Chemical News* gives a summary of experiments by Messrs. Clarence Richard Groves and Thomas Turner, from which it appears that two or more metals may volatilise together. Thus lead and zinc tend to pass over together. In the iron-zinc series also there is an increasing proportion of the iron carried over as the temperature rises from 500°. In the silver-zinc series, although separation is nearly quantitative at 700°, there is an increased loss of silver with higher temperatures.

THE FACE OF THE SKY FOR JULY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun R.A.	Sun Dec.	[illegible]	[illegible]	R.A.	[illegible]	R.A.	[illegible]	R.A.	[illegible]	R.A.	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 21.

Date. Greenwich Noon.	P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 22.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T, T are the times of passage of the two zero meridians across the centre of the disc: to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving South again. It is at its greatest distance from the Earth July $4^d\ 11^h$ *e*, its semi-diameter is then 15′ 45″·35, and 15′ 47″·0 on July 31st. Sunrise varies from $3^h\ 49^m$ to $4^h\ 24^m$; sunset from $8^h\ 18^m$ to $7^h\ 49^m$.

MERCURY is an evening star; it is in elongation, 27° from Sun July 25th. Semi-diameter increases during month from $2\frac{3}{4}$″ to $4\frac{1}{4}$″; fraction of disc illuminated diminishes from 0·8 to 0·4.

VENUS is in superior conjunction with Sun July 5th, and its disc is therefore fully illuminated, semi-diameter 4″·9.

THE MOON.—Last Quarter July $7^d\ 4^h\ 47^m$*e*; New $14^d\ 1^h\ 13^m$*e*; First Quarter $21^d\ 5^h\ 18^m$ *m*; Full $29^d\ 4^h\ 28^m$*m*. Apogee $2^d\ 1^h$*m*, semi-diameter 14′ 44·2″; Perigee $14^d\ 12^h$ *e*, semi-diameter 16′ 44·3″; Apogee $29^d\ 5^h$*m*, semi-diameter 14′ 43·5″. Maximum Librations, July 9^d, 7° E., 14^d 7° S., 21^d 8° W., 27^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E, W, are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is too near the Sun for useful observation; it is still an evening star.

JUPITER is an evening star. Its equatorial semi-diameter varies from 22″ to $20\frac{1}{2}$″, the polar is smaller by $1\frac{1}{2}$″. The configurations of the satellites at 10^h *e* are for an inverting telescope (see Table 24).

Satellite phenomena visible at Greenwich, $2^d\ 8^h\ 42^m\ 56^s$*e* III. Ec. R., $11^h\ 18^m$*e* II. Tr. I.; $3^d\ 0^h\ 42^m$*m* II. Sh. I.; $4^d\ 0^h\ 27^m$*m* I. Tr. I., $1^h\ 12^m$*m* I. Sh. I., $9^h\ 44^m$*e* I. Oc. D.,

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h m		h m	
July 2	BAC 7186	7·2			0 10 m	271
„ 2	37 Capricorni ...	5·7	11 15	121	0 2* m	105
„ 3	ε Capricorni	4·7	1 5 m	25	2 11 m	28
„ 6	BD −5° 6048 ...	7·5			0 7 m	241
„ 10	ρ² Arietis ...	6·0			0 37 m	255
„ 11	33 Tauri ...	6·0	1 30 m	52	2 20 m	206
„ 11	BAC 1238 ...	6·5	3 0 m	121	3 44 m	104
„ 18	β Virginis ...	3·8	8 58	137	[illegible] 33 e	283
„ 23 ...	BAC 5286 ...	5·4	7 43	54	8 2 e	7
„ 30	33 Capricorni	5·3	[illegible] 55 m	121	1 33 m	178

TABLE 23.—Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that printed in the date column.

From New to Full disappearances take place at the Moon's Dark Limb, from Full to New reappearances.

[illegible] I. Tr. E. [illegible] II. Oc. R. [illegible] I. Tr. I. [illegible] III. Oc. D. [illegible] III. Tr. D. [illegible] III. Tr. R. [illegible] I. Oc. D. [illegible] I. Tr. R. [illegible] I. S. E. [illegible] I. Sh. E. [illegible] I. Tr. R. [illegible] III. Oc. D. [illegible] III. Oc. R. [illegible] D. [illegible] I. Tr. E., 11h [illegible] I. S. I. [illegible] II. Sh. E., [illegible] I. Tr. R. [illegible] III. Sh. E., [illegible] I. Oc. D. [illegible] II. Tr. E., 10h 40m, III. Sh. E. [illegible] I. Tr. E., 10h [illegible] I. S. E.

Phenomena [illegible] occur on the same day.

July 2[illegible] [illegible] attention [illegible] shadow [illegible] of II. III. [illegible] while I. is occulted at the same time.

The Eclipse [illegible] of I. II. and disappearances and reappearances of III. occur high right of the inverted image, taking the direction of the belts as horizontal.

SATURN [illegible] Star, too near the Sun for convenient observation.

URANUS is in opposition on the 24th, and is therefore in its best position for the present year. It is well placed for southern observers. Semi-diameter 2". It is 5° south of Beta Capricorni.

NEPTUNE is invisible, being in conjunction with the Sun on the 16th.

METEOR SHOWERS (from Mr. Denning's List):

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
May to Aug.	333	28	Swift, streaks.
May to July	252	21	Slow, trains.
June to Aug.	310	61	Swift, streaks.
June to Sept.	335	57	Swift, slow in Sept.
June, July	245	64	Swift.
June to Aug.	303	24	Swift.
July 6—22	284	1?	Very slow.
„ 15—31	23	43	Swift, streaks.
„ 19	315	48	Swift, short.
„ 22—27	335	51	Swift, streaks.
July, Aug.	[illegible]8	12	Slow, long.
July 25 to Sept. 15	48	43	Swift, streaks.
July 28	339	1?	Slow, long, conspicuous shower, the July Aquarids.
July to Sept.	335	7?	Swift, short.
July 8—31	317	31	Swift, white.
July, Aug.	280	57	Slow, short.
July to Oct.	355	72	Swift, short.

The Perseids may be seen from July 19, radiant 23° + 52°, it advances 1° per day in R.A.

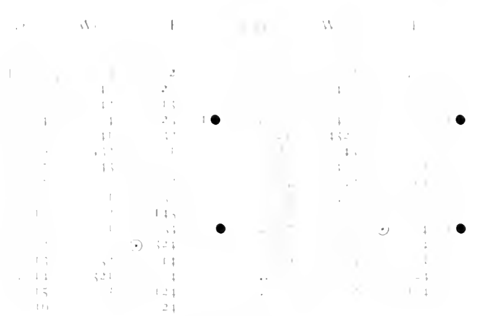


TABLE 24.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
M. [illegible]9	17 14	S 1[illegible] 4	Small cluster.
M. 92	17 14	N 4[illegible] 3	Fine cluster.
M. 14	17 32	S 3 2	Large faint cluster.
M. 23	17 51	S 19 [illegible]	Diffused cluster.
H. IV. 41	17 56	S 23	Trifid nebula.
M. 8	17 58	S 24 4	Loose cluster in rich region of galaxy.
H. IV. 37	17 59	N 66 6	Planetary nebula. First one tested by Huggins with spectroscope. Marks pole of Ecliptic.
H. VII. 30	18 7	S 2 6	Ill-defined cluster.
M. 28	18 18	S 24·9	Faint cluster. 1° N of λ Sagittarii.
H. VIII. 72	18 23	N 6 5	Fine cluster.
M. 25	18 26	S 19 2	Coarse cluster.
M. 22	18 30	S 24·0	Bright cluster. Between μ and σ Sagittarii.
H. 2 2 H.	18 45	N 10·2	Cluster.

DOUBLE STARS.—The limits of R.A. are 17h to 19h.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
[illegible] Draconis	17 4	N 54·0	5, 5	140°	2	White.
[illegible] Herculis	17 11	N 14·5	3, 6	113	5	Yellow, blue.
[illegible] Herculis	17 21	N 37·2	4½, 5	314	4	Greenish.
Σ 2173	17 26	S 1·[illegible]	6, 6	180	[illegible]	Yellow.
61 Ophiuchi	17 4[illegible]	N 2·6	5, 6	93	21	Period 40y. White.
[illegible] Herculis	17 43	N 27·8	4, 9	245	32	Yellow, blue.
Herculis; [illegible]	17 43	N 27·8	9, 10	103	[illegible]	
[illegible] Draconis	17 43	N 72·2	4, 5	15	31	White.
[illegible] Ophiuchi	17 58	S 8·2	5, 6	200	1½	Yellowish.
95 Herculis	17 58	N 21·6	5, 5	260	6	Green, red.
[illegible] Ophiuchi	18 1	N 2·5	4, 6	150	3	Yellow, purple.
Motion disturbed, probably by an invisible companion.						
[illegible] and 41 Draconis	18 7	N 80·[illegible]	5, 6	232	20	Yellow.
Aquilae [illegible]	18 [illegible]	S 1·1	6, 7	121	13	White, blue.
[illegible] Lyrae	18 41	N 39·6	5, 6	12	3	Green, blue.
Lyrae	18 42	N 39·5	5, 5	127	2	White.
These two pairs form the "Double-double."						
[illegible] Serpentis	18 52	N 4·1	4, 4	103	22	Yellow.

TABLE 25.

THE KNOWLEDGE OF METALLIC BADGES, TICKETS AND PASSES.

BY A. M. BROADLEY.

Author of "The [illegible]"

FROM the consideration of those pieces which are exclusively commemorative and historical in their

FIGURE 247.
Badge of Charles I and Henrietta Maria, presented on the occasion of their marriage.

character, and were generally preserved by their purchasers in cases and cabinets, we pass to another class which, when worn or exhibited, served to indicate the political sympathy or opinions of the owner; to denote the membership of some particular club, association or fraternity; to procure admittance to a theatre, concert room or social gathering, or to testify to the successful accomplishment of some mental or physical achievement. In most instances medallions of this kind are provided at the upper end with a loop or ring through which a ribbon could be conveniently passed. The custom of displaying them on the breast is, however, not universal. We have a notable exception in the trophy of the waterman alluded to by Charles Dibdin in the familiar lines:—

> Then farewell, my trim-built wherry
> Oars, and coat, and *badge* farewell.

The winner of Doggett's "badge" (a facsimile of which is embossed in gold on the cover of the admirable work of Messrs. T. A. Cook and Guy Nickalls, dealing with the history of the annual contest since 1714) wears the outward and visible sign of victory on his right arm. Thomas Rawlings was the maker of some of the beautiful badges which were distributed on the occasion of the marriage of King Charles I and Queen Henrietta Maria, with a view, apparently, to their being worn by the recipients. I am enabled, by the courtesy of Messrs. Spink, to reproduce two examples of these charming medallions. In the first (see Figure 247) we have the the bust of Charles I, to right, hair long, falling lace collar, doublet buttoned close, scarf across the breast. Legend incuse: CAROLVS. D. G. MAG. BRI. FR. ET. HIB. RX.

Reverse: Bust of Henrietta Maria, to left, hair flat at the top, curly at the sides, drawn through a small coronet behind and tied into a bow, pearl necklace and pendant, figured bodice with brooch in front, bust terminated in drapery. Legend: HENRIETTA. MARIA. D. G. MAG. BRITAIN. FRAN. ET. HIB. REG. Below, T. Rawlins. F. Size 1·45 by 1·15.

In the second variety (see Figure 248) we see the bust of Charles I, L., laureate, hair long, in armour with lion's head on shoulder, medal suspended to a chain, and mantle festooned upon the breast. On the reverse is the bust of Henrietta Maria, L., hair flat at the top, curly at the sides drawn through a coronet behind, and tied into a bow, pearl necklace and pendant, figured bodice with brooch in front, bust terminated in drapery. In this case there is no legend, but we have neat floral and corded borders on both sides. Size 1·25 by 1. In both instances there are rings for suspension, but this medal occurs without the borders. These pieces are both by Thomas Rawlings.

FIGURE 248.
A smaller Badge of Charles I and Henrietta Maria.

Exceeding scarce is the medallion worn as a memento of that gallant gentleman, Sir Henry Slingesby, who was be-

FIGURE 249.
A very rare Medallion commemorating Sir Henry Slingesby who was beheaded in 1658.

headed in [illegible], a specimen of which is in the collection of Messrs. Spink (see Figure 250). It is thus described: Half-length figure of Sir Henry Slingesby, nearly full face, hair long, in armour and O: C: 1658. Size — 1·85 by 1·55. Cast, untouched by the graver; ring for suspension. This badge has a very special interest for York collectors for Sir Henry Slingesby belonged to an ancient

FIGURE 250.

Loyalist Badges and Medals associated with the adventures of Charles II between 1649 and 1660. Arranged by Messrs. Spink for the collection of A. M. Broadley.

sash round his waist. Outer Legend — EX. RESIDVIS. NVMMI. SVB. HASTA. PIMMIANA. LEGE. PRÆ. DATI. IVXTA. DAVENTRIAM. (From the residue of the money plundered near Daventry under the military authority of Pym.) Inner Legend — YN. EARNEST. PENNY. FOR. MY. CHILDREN. THO: H: B: SLINGESBY. B. OXON. 1644. Reverse engraved. Armorial shield with mantling and crest. Slingesby impaling Belasyse. Below, beheaded Iun: 8 : 8 : by family in that county. He was attached to the royalist party, and having been made prisoner, was, after two years' confinement at Hull, brought up to London and executed on Tower Hill, 8th June, 1658; or, as it is stated in the Harl. M.S. 4630, "he was condemned by a High Court of Justice, as it was then called, upon the information of one Rafe Waterhouse, a very mean person, and beheaded or basely murthered." He had married Barbara, daughter of Thomas Belasyse, Viscount Fauconberg, and aunt to Thomas, Lord Fauconberg, the husband of Mary, daughter of Cromwell, and had issue the three children, Thomas, Henry, and Barbara, for whom this medal was made. After the surrender of York, Sir Henry Slingesby, with a portion of the army, made his way to Oxford, where he arrived after many perils, especially from an attack of the rebel horse near Daventry, where he lost all that he had. At Oxford he had his quarters with Sir William Parkhurst, Master of the Mint, which may account for the execution of this medal. It is probably the work of Thomas Rawlings.

Figure 251.
The Badge of the Loyal Association of 1745.

Figure 252.
Portrait Badge of Prince Charles Edward, 1745.

Figure 253.
Badge of the President of the Beefsteak Club, formerly the property of Sir Henry Irving, now in the collection of A. M. Broadley.

In my book, "The Royal Miracle," just published by Mr. Stanley Paul, I have described at length the various badges worn or preserved between 1649 and 1660 by the loyal adherents of the exiled King. The entire series of these interesting medals in my collection is now reproduced (see Figure 250). In the centre will be seen a small miniature painting of the fugitive Charles, executed on copper, which has been pierced at the upper end, evidently to facilitate its being worn by the original owner. It is possible that other examples of these loyalist badges are in the Stuart collection of Miss Helen Farquhar.

It is curious to contrast the two badges of 1745, both of which are now illustrated. On one we have a very fair portrait of the Young Pretender (see Figure 252). Its object is sufficiently obvious. England and Austria were closely allied during the war of the Austrian succession (1741–1748), and at this critical juncture, especially in 1745, many associations were formed to support the reigning House of Hanover. The badge or medal of the Loyal Association of 1745 (see Figure 251) is thus described: Round it runs the legend, WHERE HEARTS ARE RIGHT, LET HANDS UNITE. Two men grasp hands. Ex. FOUNDED IN THE FRENCH WAR, 1745. Reverse, THESE BANNERS SPREAD, ARE GALLIA'S DREAD. Shield bearing St. George piercing the shield of France; supporters, the British lion and the Austrian eagle; crest, Britannia,

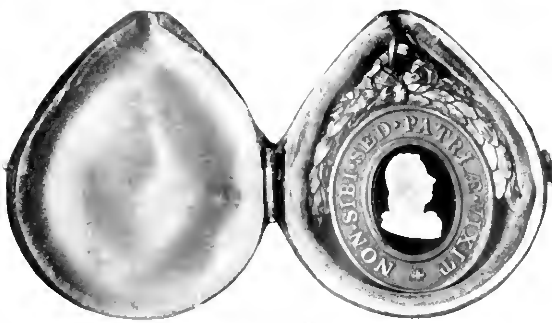


Figure 254.
Cameo Jewel of the London Pitt Club, in the collection of A. M. Broadley.

FIGURE 255.
The very rare silver gilt Badge of the Beggar's Benison Club at Anstruther, Scotland. In the collection of A. M. Broadley.

two flags at either side; motto, FOR OUR COUNTRY.

The reverse of this medal is beautifully reproduced in enamel in the centre of the elaborate badge, surrounded with fine paste ornaments, now in my collection. This was probably worn by the President of the Loyal Association, who may have belonged to the fair sex.

In 1789, after the famous battle of the Regency, a medal was struck both in pewter and gilt bronze in honour of William Pitt, bearing on the reverse the words: "May Britain still flourish under our good King and his virtuous Minister." Another medal of that momentous year shewed the head of Pitt, the Premier, on one side and that of Thurlow, the Chancellor, on the other. From 1789 onwards Pitt was the object of many medallic honours, but it was not till after his death at the beginning of 1806 that innumerable Pitt Clubs came into existence with a view to perpetuate at once the policy, the patriotism and the memory of the "Pilot who weathered the storm." Of these loyal associations the London Pitt Club is probably the sole survivor, for the non-political Cambridge Pitt Club was founded at a later date, and for a different purpose. Nearly every Pitt Club had its own distinctive badge, some of them being now extremely rare, but in one or two instances a Pitt commemorative medal was used, with a special border and suspensory loop added to it. The silver gilt and cameo badge of the parent Pitt Club, that of London, is now reproduced (see Figure 254). The original cameo, from which the others were copied, is, I believe, now in possession of Dr. Fletcher, the President and Treasurer of the Cambridge Pitt Club. It was cut about 1790 by James Tassie, a British modeller (1735-1799), a full account of whose work will be found in the issue of the *Numismatic Circular* of May, 1912. The provincial Pitt Club badges in my possession are those of Liverpool (Wyon, Junr.) 1814, Nottingham (Webb) 1814, Manchester (Wyon) 1813, Stirling 1814, Warrington 1814, Birmingham 1814, Wolverhampton (Wyon) 1813, Leicester Town and Country (Webb) no date, Blackburn (Halliday) 1814, Rochdale (Webb), 1813 and Sheffield 1810. They are all in silver. The finest of them is that of Rochdale, which has on the obverse a profile portrait of Pitt, with the words "Gulielmo Pitt. R. P. Q. B." On the reverse is a storm-beaten rock and the legend *Patriae columen decus.* The majority of the Pitt medals have the motto *Non sibi sed patriae vixit.*

FIGURE 256.
Gilt and enamel badge given by George III to his physicians after his recovery from his mental affliction in 1789. In the collection of A. M. Broadley.

Most of the eighteenth-century clubs (and their name was legion) had their distinctive badge. The Beefsteak Club certainly dated from that period, but on the reverse of the large and handsome silver gilt badge (once the property of Sir Henry Irving) now reproduced, are the following words:—"15 Nov: 1803. Founders Sir John Turner,

FIGURE 257.
Silver Masonic Medal or Badge given by William, Duke of Cumberland, to Ralph Allen of Bath, in 1752. In the collection of A. M. Broadley.

E. Foulkes, R. Ramsbottom, I. Nixon" (see Figure). Any explanation of this motto would be welcomed by . On the obverse is engraved the motto *Esto perpetua ad lib*. At the establishment of Mr. A. H. Baldwin in Duncannon Street the writer recently saw the badge of the "Leg of Mutton" Club—a *gigot au naturel* neatly chased in solid silver. The rare badge of the Beggars' Benison Club (see Figure 255) which was obtained for the writer by Mr. Baldwin, is characteristic of the eighteenth century, to which it belongs. On the obverse are depicted Adam and Eve, naked, standing facing, their hands joined: Adam points to a bower: at their feet a lion. Legend: "Be fruitful and multiply." On the reverse is Venus, recumbent, beneath a canopy; at her side Cupid; behind, Adonis with a spear, and a dog under a tree. Legend: "Lose no opportunity." This medal has a loop for suspension, and the example given shews a piece of the original ribbon. "The Beggars' Benison" was instituted at Anstruther about 1739, ostensibly as an association for the collection of "good" songs, stories, jokes, and *facetiae* of all kinds, but in reality to serve as an outlet for the most exuberant and outrageous fun and familiarity of the toughest description. It included eminent men of all classes, besides many noblemen, and even some members of the Royal Family. Each member upon his institution paid an entrance fee of ten guineas and received an elaborately-illuminated diploma, as well as the badge of the order. This club came to an end about 1830. The badge given by George III to his medical attendants after his recovery in 1789 is very scarce (see Figure 256), but needs no special description. Later in this year many medals and tokens were struck to commemorate the visit of the King and Royal Family both to Weymouth and Plymouth. Books might very well be written both on the Pitt Club badges and those which form part of the insignia of Freemasonry.

The Grand Lodge of Freemasons originated in 1717, and enormous prices are given for medals and badges connected with the early portion of the

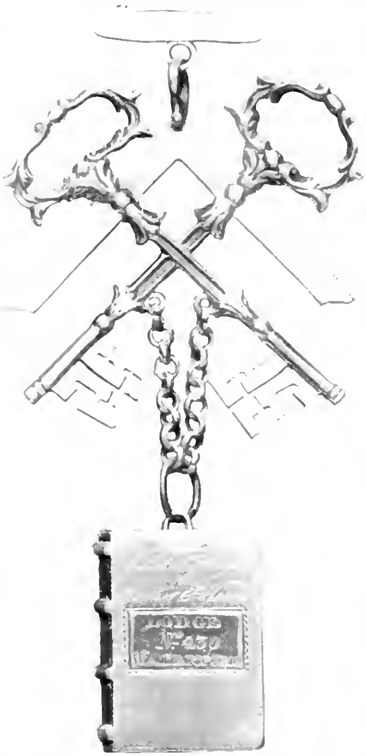


Figure 258.
Masonic Badge given to Edmund Kean by J. Latrobe Wright of Waterford, formerly owned by Sir H. Irving, and now in the collection of A. M. Broadley.

Figure 259.
Silver pass to Drury Lane Theatre given by David Garrick to his physician, Dr. Schomberg (1770). In the collection of A. M. Broadley.

Figure 260.
Pass to the Prince Regent's box at the King's Theatre, Haymarket (1814). In the collection of A. M. Broadley.

Figure 261.
Silver pass of Smock Alley Theatre, Dublin. In the possession of Messrs. Maggs.

history [illegible] powerful social and philanthropic society. [illegible] were also used by the members of other [illegible] formed in imitation of the Freemasons, [illegible] the "Bucks," the "Sols," the "[illegible]," and many others. Colonel Sir W. Watts, K.C.[illegible], succeeded in obtaining specimens of the [illegible] worn both by the "Bucks" and "Sols." A [illegible] rare and curious medal of a Masonic character (certainly intended to be worn) is in the possession of the writer. It was thus described in the Bunck Sale, of November 27th–29th, 1907, at Sotheby's: "A large engraved badge (see Figure 257); on one side is engraved the Royal Arms, and the legend

The gift of His Royal Highness W.D. of Cumberland To the Famous Mr. Allen 1 Dec 1752.

The reverse has a number of Masonic emblems and the name of ***John Campbell*** of Armagh." After seeing an illustration of it, the late Mr. W. J. Hughan wrote to me that he regarded the badge "as one of the most curious and valuable in existence." I have already dealt in detail with the history and associations of the Ralph Allen medal in the pages of *The Numismatic Circular, Somerset and Dorset Notes and Queries,* and the *Transactions of the Dorset Masters Lodge, No. 3366.* It is not absolutely certain that Duke William was a member of the Masonic Order, but there are grounds for believing that he belonged to it. The inscription on the reverse is certainly posterior to that on the obverse by at least eleven years, and the late Mr. Hughan was of opinion that the emblems themselves are of the 1752 period if not earlier. The late Mr. Sadler said the postdating of Mason medals is of frequent occurrence, and several examples of it occur in the collection which owes so much to his knowledge and enthusiasm. Possibly Ralph Allen, not being a Freemason, may have given the medal to John Campbell, who belonged to the Craft, for the genial owner of Prior Park lived quite six months after the formation of the lodge at Armagh. It may be that the relic came to him through Allen's heir, and that the second inscription is older than 1763 or 1764. The only one of the numerous John Campbells in the D. N. B. whose dates coincide with it on the medal, is a gallant sailor who went round the world with Anson. Admiral Campbell was born in 1720 and died in 1790.

The learned Dorset editor of the *Somerset and Dorset Notes and Queries* added the following note to my original remarks on the Cumberland-Allen Medal, with my entire acquiescence:

"I believe that this interesting badge was not, at first, of a Masonic character, but a simple ***pignus amoris*** from the Duke of Cumberland to his friend. I take it that when it came, by gift or purchase, into the hands of John Campbell, the reverse, hitherto blank, was engraved with the present Masonic design, and the two small Masonic emblems inserted on the obverse. The engraving of these two emblems, and of those on the reverse, suggest the hand of an inferior workman, and the crookedness of one of the pillars, the want of correctness in the curve of the surrounding oval, the irregularity of the lettering, and the poverty of the mantling on the reverse, so different from the fine work of the mantling above the Royal Arms, seem to indicate additions by a less skilled or a provincial engraver, who may have copied an old model, or whose want of skill has imparted an antiquated character to his work."

Edmund Kean, quite early in life, became a Freemason, and it was the "brethren of the Mystic Tie" in Dorchester who helped him on his road to Drury Lane and celebrity, when the chance of a lifetime came to him on January 26th, 1814. From the collection of the late Sir H. Irving (also a Freemason) came the fine and curious badge given to Kean by Mr. J. Latrobe Wright, of Lodge No. 230, Waterford. (See Figure 258).

Admission tickets to theatres, masquerades, concerts and other entertainments are sufficiently abundant. They are generally of metal, but are occasionally engraved on bone or ivory. The unique badge-ticket to Drury Lane (for it has a loop for suspension) which David Garrick gave to his medical attendant, Dr. Isaac Schomberg, is extremely interesting. (See Figure 259). A full-length figure of Shakespeare appears on the silver pass to the Smock Alley Theatre, Dublin, now in possession of Messrs. Maggs, of 109, Strand. It is thus described by the present owners: "A very rare silver pass engraved with full-length portrait of Shakespeare shewn leaning on pedestal; on the reverse, inscription along top '*Theatre in Smock Alley,*' and underneath '*The Rt. Honble. the Countess of Branden.*' The Pass is circular in shape and measures about four-and-a-half inches in circumference. Preserved in a neat leather case." (See figure 261).

In the fine collection of the late Mr. Montague Guest were several metal passes to Vauxhall and Ranelagh Gardens. The writer possesses similar admission-passes to both the historic theatres in the Haymarket. They vary from the humble copper pit order, which enabled the possessor to enjoy the drollery of Samuel Foote, to the gold and silver medals given to the box-holders of the Italian Opera across the way. The elaborate silver-gilt badge now reproduced was presumably an open sesame to the King's Theatre box of the Prince Regent between 1812 and 1820. Its weight must have proved somewhat trying to the wearer. (See Figure 260).

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

THE ECLIPSE OF THE SUN, APRIL 17TH. Fine weather favoured this phenomenon along the central line, and the spectacle was enjoyed by a large number of visitors from this country. It was known in advance that only the most fleeting glimpse of the corona could be expected; this was obtained by a few, including Professor Turner. In Portugal, Mr. Worthington saw it for several seconds, and was able to note that it was of the "wind vane" type associated with spot-minimum. Mr. Slater succeeded in photographing it.

The duration of totality in Portugal given by *The Nautical Almanac* (half a second) was verified, thus showing that the diameter of the Moon used for eclipses is correct. As regards the position of the central line, the American Ephemeris is to be congratulated on its successful prediction. It applied +9"·8, +1"·7 to the calculated longitude and latitude of the Moon, the result showing that these corrections were very nearly right, but probably that in longitude should be slightly increased, and that in latitude diminished. Our *Nautical Almanac* and the German one did not attempt to correct the Moon's place, and their tracks were two or three miles too far to the N.W.; the French one corrected the Moon's R.A. but not her Dec., and its track was a mile and a half too far S.E.

The eclipse near Paris was neither total nor annular, though many observers erroneously used the latter term. An *annulus* means an unbroken ring. I observed by projection on a white screen, thus reducing irradiation, and I can say with confidence that there was not a continuous ring of sunlight, but only disconnected patches in the depressed parts of the Moon's limb. Baily's Beads were beautifully seen.

The light at mid-eclipse grew quite dim, and of a weird reddish or purplish tinge. M. Antoniadi ascribed this to the fact that we were only receiving light from the extreme edge of the Sun, which has to traverse a great extent of solar atmosphere, most of the blue light being absorbed.

M. and Mme. Antoniadi made interesting observations of the shadow bands, which they describe as wriggling snakes moving rapidly in the direction of their own length in a direction nearly away from the Sun, *i.e.*, from S.S.W. to N.N.E. (this was also the direction of the wind) at a speed about equal to that of a running man. In most eclipses the motion of the bands has been transverse to their length.

THE INTERESTING MINOR PLANET M.T. — The discovery and loss last October of this interesting body will be remembered. It was discovered by Dr. Palisa at Vienna, and was remarkable for the fact that, although in opposition, it was *advancing* pretty rapidly in R.A. Hence its orbit is evidently highly eccentric. There is not really enough observational material to determine the orbit, the following four positions being all that are available; the first two were made by Palisa at Vienna, the others by Pechule at Copenhagen:—

Local M.T. 1911		Apparent R.A.		Apparent Dec.
Oct. 3d 14h 51m 56s·0	...	0h 42m 47s·83	...	N.0° 15' 40"·8
„ 4 10 49 41·3	...	0 43 43·50	...	S.0 12 48·9
„ 4 14 11 3·0	...	0 43 58·09	...	S.0 17 50·8
„ 4 15 7 5·0	...	0 44 3·14	...	S.0 19 12·5

With this material two independent determinations of the orbit have been made; the first by F. S. Haynes and J. H. Pitman in *Lick Bulletin*, No. 210, the second by Dr. Franz in *Astr. Nachr.*, 4571. The first seems entitled to rather more confidence from the more reasonable values of the eccentricity and period; there is one point in favour of Franz's orbit, *viz.*, it makes the diminution of brightness more rapid, which would explain the failure to recover the planet towards the end of October. It will be seen that the node, inclination, time of perihelion, and perihelion distance are known to be fairly approximate, but that the eccentricity and period are subject to great uncertainty. Both the orbits are referred to the ecliptic and equinox of 1911·0.

	Lick Orbit			Franz Orbit
T ...	...1911 Aug. 20·[illegible]8 G.M.T.			Aug. 15·497 G.M.T.
ω ...	...141° 20' 27"	..	...	127° 37' 39"
Ω	...185 5 54	.		185 54 27
i ...	... 9 41 24		.	11 28 42
e ...	...0·5097		.	0·8153
μ ...	...1050"·1		..	284"·8
a ...	...2·2538	.	.	5·387
Period	...3·379 years		...	12·50 years
q ...	...1·1048	..	..	0·995
Aphn. dist.	...3·3988	...	..	9·779

Both orbits make the brightness a maximum a month before discovery, when it was probably of the tenth magnitude, and being in high north declination there is still a chance that some further images may be found on photographs in September or October. The ephemeris from the Lick orbit is given to illustrate the curious motion of such an eccentric body when near the earth. It is for Greenwich midnight.

1911	R.A.		Dec.		Dist. from Earth		Mag.
Sept. 1	22h 15m·8	.	31° 3' N.	...	·1318	...	10·7
„ 9	23 11·1	...	22 45	...	·1359	.	
„ 17	23 53·2	...	13 44	...	·1515	...	11·1
„ 25	0 22·4	...	6 0	...	·1779	...	
Oct. 3	0 43·0	...	0 19 N.	...	·2140	...	12·0
„ 11	0 55·2	...	3 29 S.	...	·2585	...	
„ 19	1 4·6	...	5 47	...	·3112	...	12·9
„ 27	1 12·0	...	6 56	...	·3718	...	
Nov. 4	1 18·7	...	7 15	...	·4403	...	13·8
„ 12	1 25·2	...	6 58	. .	·5167	..	
„ 20	1 32·0	...	6 15 S.	...	·6010	...	14·6

With the aid of this ephemeris, images of the planet have just been found on three plates taken at Greenwich on October 11th. These will enable a more reliable orbit to be calculated; there has not been time to do this yet. The observed R.A. is 32 sec. greater than the ephemeris, the observed Dec. 11' 25" south. It would seem that the eccentricity is smaller even than the Lick value.

ROTATION OF URANUS. — The extreme difficulty of ascertaining the period of rotation of Uranus by direct observation of the disc is well known, as spots are rarely seen, and when seen they are usually of a belt character, giving no definite point to select. In the March number I described Professor Bergstrand's attempt to determine it by the motion of the peri-uranium of the nearest satellite, Ariel. He gave the rather wide range of 11·5 to 17·6 hours, thinking thirteen hours the most probable.

At the May meeting of the Royal Astronomical Society, Professor P. Lowell exhibited and described a beautiful series of photographs of the spectrum of Uranus, taken by Mr. Slipher at the Flagstaff Observatory. It is only in the last few years that the position of Uranus has made the application of the method possible, as before that its pole (assumed to be coincident with the pole of the orbit-plane of the satellites) had been for several years nearly central in the disc, so that there was no rotational movement in the line of sight. The slit was placed in the direction that would produce the maximum inclination of the spectral lines as compared with those of the comparison spectrum, and the inclination obtained is quite obvious to the eye, and fully ten times the estimated probable error of a determination of inclination for one line. Several lines were measured, and the result deduced that Uranus rotates in a retrograde direction in a period of ten and three-quarter hours. This is quite a reasonable result, being near Bergstrand's lower limit, and we may take it as by far the most reliable value yet obtained. See's estimate of $10^h\ 7^m$ was in tolerable accordance with it. We may hope that the spectroscopic method will be applied to Neptune also.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

THE SOIL AND THE PLANT. Under this title, Dr. Russell has recently (*Science Progress*, No. 21, 1911) discussed various problems raised by the researches of the past few years into the relations between plants and the soil. He points out that both the chemical and physical properties of the soil affect the growth and health of the plant; also that it is most improbable, as suggested by some recent workers, that the chemical properties of the soil are relatively insignificant in determining fertility. A deficiency in any one factor limits the effectiveness of the rest, and many of the injurious or inhibiting factors are profoundly influenced by the presence or absence of calcium carbonate in the soil. He criticises the various theories brought forward by the members of the United States Bureau of Soils, regarding the concentration of the soil solution, its constancy of composition, the toxic nature of certain soil water for plant growth, and the part played by fertilisers. As to toxic or poisonous substances, it cannot be taken as proved that a substance toxic in water culture is necessarily toxic in the soil itself, as the soil possesses absorptive properties. Moreover, no evidence of the existence of poisonous plant excretions in the soil has yet been obtained, and the continuous growth of wheat on one field at Rothamsted for nearly seventy years is cited as a proof to the contrary.

In this review, it is clearly shown how complex is the relationship between the soil and the plant, and how important a part is played by the biological factors, as well as the chemical and physical constitution of the soil, in determining the total effect upon plant growth. A list of the recent literature on the subject is appended to the paper.

BRITISH ELMS. The Elms which occur native or naturalised in this country are often difficult to determine, owing to variation in the size and hairiness of the leaves, the presence or absence of suberosity, and the occurrence of hybrids. Dr. Moss has contributed to *The Gardeners' Chronicle* a series of articles (*G. C.*, Nos. 3718–3720) on the British Elms, in which most of this confusion has been cleared up. The various species and hybrids are critically described and discussed, and a new variety is indicated. The author points out, in dealing with the question of hybrid Elms, that the early interpretation of the occurrence of such forms—that plants yielding mixed seedlings were not good species—has had a good deal to do with the reduction by many botanists of British Elms to two or even to one species. This view is discredited by the recent results of experiments which show that a "pure line" may yield seeds producing mixed seedlings if pollinated either by another "pure line" or by a hybrid; hence it is now necessary, before it can be said that a plant of unknown origin is a hybrid, to self-pollinate the plants and use only the seeds obtained by this means. If such seeds yield mixed seedlings, it may be regarded as established that the plant which produced them is a hybrid. Even then, however, there is no proof of the parentage of the hybrid. To obtain such proof, it is necessary to produce the hybrid in question by cross-pollinating known plants, and apparently this has not yet been done in the case of Elms.

The formation of an excess of corky tissue is to be regarded as an abnormality which may occur in any of our Elms, except the Wych Elm (*Ulmus glabra*). Such names as "*Ulmus suberosa*" or "*Ulmus campestris* var. *suberosa*," if founded on the presence of suberous bark alone, are to be rejected. The occurrence of suberosity is common in some cases (e.g., the Dutch Elm) and rare in others (e.g., the Huntingdon Elm). The suberosity is commonest on the young branches produced from adventitious buds low down on the trunk and on suckers. Its cause is a matter for investigation by the plant pathologist rather than the systematist, but it is interesting to note that all our Elms which produce suberous bark also have suckers.

Another cause of confusion is the smoothness or roughness of the upper surface of the leaves. In the Wych Elm and English Elm all the leaves are rough above, but the remaining Elms are usually described as having the leaves smooth above. This, however, only applies to leaves produced in Spring on young branchlets of the main branches (called "normal leaves" in the Key). It does not apply to leaves formed on suckers, or on twigs produced from adventitious buds low down on the trunk, or on coppiced or cropped shoots, or on seedlings, or even on the new shoots produced in summer on the main branches—all these leaves are invariably rough above. This, the author believes, has never been pointed out before; and in assessing the value of old descriptions it is sometimes necessary to reject all references to the smoothness or hairiness of Elm leaves.

The *size* of Elm leaves has also led to confusion, through not allowing for the variability in each species, variety, or hybrid. On every shoot, of course, the size of Elm leaves varies considerably; and in the Key the descriptions of the leaves refer only to the terminal leaves of each branch, unless otherwise stated. By allowing for some variation, it is possible to identify any British Elm by its normal leaves alone.

As the present writer has frequently had specimens of Elms sent to him for identification by readers of "KNOWLEDGE" and other students of our British trees, it may be useful to reproduce here the key given by Dr. Moss at the conclusion of his articles on the British Elms. Permission to do this has been kindly granted by Dr. Moss and by the Editor of *The Gardeners' Chronicle*. In the Key, an asterisk (*) indicates that the tree is not indigenous in the British Isles, a dagger (†) that it is doubtfully indigenous. The Wych Elm (*U. glabra*) is indigenous throughout Britain; *U. nitens* and *U. sativa* are indigenous in south-eastern England and in the Eastern Midlands (*U. sativa* is also possibly indigenous in Hampshire and Glamorganshire); the Dutch Elm seems to be indigenous in Cambridgeshire and no doubt elsewhere.

I.

Tree without suckers and without suberous bark; branches usually more or less arched; crown of tree large; stamens usually five or six, rarely four or seven; samara large (about one inch long), seed in the centre; laminae always rough above and acuminate, of the terminal leaves large (about five inches long and nearly three broad), almost sessile. WYCH ELM (*U. glabra* Hudson).

Tree with suckers; bark suberous or not; stamens usually four; seed usually between centre of samara and the notch. —II.

II.

Tree very tall at maturity; bole long, straight; lower branches§ wide-spreading; crown large; samara small (about half an inch long), suborbicular; laminae always hairy or rough above, of the terminal leaves rather large (about three and a half inches long and two inches broad) and acute-acuminate, of the remaining leaves of each branchlet shorter, suborbicular; petioles about one-third of a inch long, hairy. —†ENGLISH ELM (*U. campestris* L.)

Normal leaves smooth or glabrous above. III.

III.

Samarae and laminae of the terminal leaves as broad as or nearly as broad as those of the Wych Elm; position of seed variable. IV (Hybrid Elms).

Samarae and laminae of the terminal leaves much narrower than in the Wych Elm; seed between centre of samara and the notch. V.

IV.

Bole usually short; lower branches widespreading and usually very long; crown very large; laminae acute, of the terminal leaves about four inches long; petioles nearly a half inch long, hairy.—DUTCH ELM (*U. glabra* × *nitens*—*U.* × *U. hollandica*).

§ The lower branches of hedgerow trees are usually lopped, and thus the typical habit is destroyed. In some districts, e.g., in Brittany, the branches are lopped almost from foot to crown, and then the precise determination of the tree is a matter of difficulty.

Bole usually short; all the main branches of young trees ascending at a very acute angle; crown very large; laminae acute-acuminate, of the terminal leaves about five inches long; petioles about a half inch long, usually hairy. HUNTINGTON ELM (*U. glabra* × *nitens*—(b) × *U. vegeta.*)

V.

Tree tall at maturity; bole long, straight; lower branches wide-spreading; crown rather large; samara small, rather less than half inch broad, obovate; laminae acute or acuminate, very smooth and shiny above, of the terminal leaves about three and a half to four and a half inches long and about two inches broad; petiole about a half inch long, glabrous at maturity.—SMOOTH-LEAVED ELM (*U. nitens* Moench).

Tree small; laminae of the terminal leaves short, less than two and three-quarters inches long.—VI.

VI.

Tree not pyramidal; lower branches wide-spreading; crown usually small, sometimes rather large when the upper branches of old trees are very tortuous; winter buds usually smaller than in any other Elm; this and *U. stricta* are the last Elms to come into flower; samara small, narrower than in any other British Elm, being only about three-tenths of an inch wide, oblong-elliptical; laminae acute or sub-obtuse, never acuminate, of the terminal leaves about two to two and three-quarters inches long or even shorter, and about one and a quarter to one and a half inches broad; petiole about two-fifths of an inch long, usually rather hairy and rough.—SMALL-LEAVED ELM (*U. sativa* Miller.)

Tree pyramidal; branches fastigiate or sub-fastigiate.—VII.

VII.

Branches fastigiate; samarae about a half inch wide, slightly obovate; laminae about as broad as in *U. sativa*, each half bent inwards or upwards on the midrib (when fresh), subcoriaceous; petiole as in *U. sativa*.—CORNISH ELM (*U. stricta* Lindley).

Branches subfastigiate; laminae flat, broader (about one five-eighths to one and three-quarters of an inch broad) than in *U. stricta*.—JERSEY ELM (*U. stricta* var. *sarniensis* Moss).

CHEMISTRY.

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

SPONTANEOUS COMBUSTION OF CHARCOAL.—The Report of the National Physical Laboratory for 1911, which has recently been published, contains (on p. 86) an interesting account of the results of experiments made to ascertain the liability of charcoal to undergo spontaneous combustion.

In these experiments one cubic foot of the charcoal was exposed in an electrically-heated oven to temperatures which were kept constant within 1° C. by means of thermo-couples. An air-space of about three inches was provided all round the charcoal, and the observations were made both with the oven kept tightly closed and with charcoal exposed to air currents of regulated velocity. It was found that when flake charcoal was heated in currents of air varying from five to sixty-two cubic feet per minute, for one cubic foot of the charcoal, ignition occurred at temperatures of 96° to 110° C., but that at lower temperatures there were no indications of spontaneous heating.

Exposure of the charcoal to a current of air containing five per cent. of sulphur dioxide caused spontaneous ignition to take place in the course of a few hours. From these results the conclusion is drawn that disinfection of a room by means of sulphur dioxide may be attended with some risk of spontaneous combustion when the walls contain charcoal. There is much less chance, however, of decayed wood becoming ignited in this way, as it does not take fire so readily as charcoal.

ARSENIC IN VEGETABLE PRODUCTS.—Since it has been shown by MM. Gautier and Bertrand, that arsenic occurs normally in the tissues of man and of animals, various investigations have been made to discover the source of the arsenic. Experiments made by MM. Stein, Gautier and Claussmann have indicated that the arsenic probably originates chiefly from vegetable foods, and its presence has hitherto been detected in cabbages, potatoes, wheat and sorrel.

This conclusion now receives confirmation from the experiments of MM. Jadin and Astruc (*Comptes Rendus*, 1912, CLIV, 893), who have made a systematic examination of thirty-six different kinds of vegetable products, including fungi, fresh and dried vegetables, cereals, nuts, and fresh and dried fruits.

In each case the arsenic was estimated by a modification of Marsh's method, with all the usual precautions as to purity of reagents and so on, and the results were expressed in milligrammes per 100 grammes of material.

Arsenic was present in varying proportions in every instance. Thus, in the fresh vegetables it ranged from 0·004 milligramme in peas to 0·025 milligramme in lettuce, while the edible portion of fresh fruits yielded from 0·005 milligramme (chestnuts and apples) to 0·012 milligramme (mandarines). Mushrooms contained 0·006 milligramme and truffles 0·020 milligramme.

PURITY OF LONDON'S WATER SUPPLY. The Seventh Annual Report (for 1911) of the Metropolitan Water Board gives further details of the researches of Mr. A. C. Houston upon the vitality of pathogenic micro-organisms in water. Various bacteria were added to samples of river water, and cultivations made to ascertain how long they survived. The results confirmed those previously recorded, and showed that typhoid bacilli did not survive more than three weeks under these conditions, their vitality being thus much lower than in the laboratory cultivations.

Other experiments upon the river water as received showed that it is exceptional for pathogenic micro-organisms to be found in small quantities of the water. Out of seven thousand nine hundred and ninety-one colonies examined, only one micro-organism resembling the typhoid bacillus was found.

From these results it would seem that storage of river water for a month is practically sufficient to destroy all typhoid bacilli.

Lowering the temperature had a curious effect in prolonging the life of typhoid bacilli added to river water, temperatures below 41° F. being much more favourable to their survival. Yet, even in the case of water chilled to the freezing point, only one typhoid bacillus was alive after a month.

A marked improvement in the chemical and bacteriological character of the river water was effected by a preliminary storage for a day in small reservoirs, prior to its being transferred into the main storage reservoirs. This improvement was still further enhanced by treating the water with a small proportion of an "alumino-ferric" coagulating agent, on its way through the small reservoir.

FERTILISING ACTION OF SULPHUR.—According to M. A. Demolon (*Comptes Rend.*, 1912, CLIV, 524) residues from the gas works are extensively used in the North of France as fertilisers for the soil. Analyses of various samples of the material showed that it contained about forty per cent. of sulphur, and from one to three per cent. of nitrogen in the form of ammonia or its salts.

The value of the substance as manure was found to depend upon the sulphur, and this conclusion was confirmed by practical tests in which flowers of sulphur were incorporated with garden soil. In every instance, the growth, both of the roots and the leaves, was promoted, and the colour of the plants was a deeper green. Apparently, the sulphur acts by stimulating the formation of chlorophyll. A portion of it becomes oxidised to sulphate in the soil.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

AUSTRALIAN GLACIATIONS.—W. Howchin writes on this subject in *The Journal of Geology*, April-May, 1912. Australia has experienced three well-defined periods of glaciation in the Cambrian, Permo-Carboniferous and Pleistocene.

In each case the distinctive evidences of ice action are unmistakeable and wide-spread. So clear and typical are they in the remoter periods that it is difficult to realise their antiquity.

The Cambrian glacial deposits are best developed in South Australia. They form portions of a non-fossiliferous series underlying a very thick formation containing numerous limestones crowded with the typical Cambrian fossils. The glacial beds have a lateral extent of two hundred miles, and consist mostly of boulder clay or till, with stones reaching nine feet in diameter. The included stones are erratics, granites, gneisses, and so on, which cannot be matched anywhere within the limits of South Australia. Photographs of glaciated stones and an exposure of till shew that the material is identical with that of recent glacial deposits. Great earth-pressure, which has been sufficient to produce cleavage in the mudstone base, has not availed to destroy the scratches and facetting of the included stones.

The most important glaciation of Australia, alike in its variety of features, wide distribution and stratigraphical development is that of the Permo-Carboniferous. Each of the Australian States and Tasmania have representatives of these deposits. In addition to the features already enumerated in the Cambrian, this glaciation also shews smoothed and striated glacial floors and roche moutonnée outlines now exposed by denudation. The Cambrian till is interbedded with true marine deposits and is regarded as having been deposited by floating ice. The Permo-Carboniferous, however, must have been land ice, as is shewn by the absence of contemporaneous marine deposits, by striated pavements, and roches moutonnées. The general direction of ice-movement was from south to north, and the centre of distribution must have been well to the south of the present continent.

The Pleistocene glaciation was relatively small and was restricted to the south-eastern highlands of the present continent and the greatest altitudes in Tasmania. It presents most of the usual features and it is unnecessary to describe it here.

Striking photographs of the products of the ancient glaciations and a full bibliography are given with this important paper.

HUMAN SKELETON IN GLACIAL DEPOSITS AT IPSWICH.—The need for caution in dealing with human remains found in recent deposits is exemplified by two very interesting notes by G. Slater, F.G.S., and Professor T. McKenny Hughes in the April number of *The Geological Magazine*, on the discovery of a human skeleton in glacial deposits at Ipswich.

The pit in which the bones were found shews a considerable thickness of sand and gravel, covered by a bed of weathered clay four feet thick, including the soil-cap, and only two feet thick in the trench where the bones were discovered. Both Mr. Whittaker and Dr. Marr, who examined the section after the bones had been removed, identify the material as weathered and decalcified chalky boulder clay. The skull is filled with the same material, and it is thus evident that at the time the skull came into position the clay was in a very moist and waterlogged condition. Dr. Marr thinks it possible that the clay may have flowed from a higher level as a result of being water-logged, but does not undertake to distinguish a thin mass of such slipped material from true, undisturbed boulder clay. According to Mr. Slater there is a slope of fifty feet in half a mile on the plateau to the east of the pit, and he thinks it reasonable to suppose that at least the upper part of the clay in the section is due to rainwash. The bones were found partly in the clay and partly in the underlying sand, and it is difficult to understand how this could have occurred naturally, considering the different modes of deposition of the clay and sand. According to Mr. Slater all the evidence points to the probability that the man was buried in a narrow and shallow grave, but there is no way of arriving at a determination of the age of the interment.

Stress has been laid on the point that no indication of a grave could be seen in the section. Professor McKenny Hughes has an interesting letter on this subject in the same issue of *The Geological Magazine*. He instances the case of a Roman and Saxon cemetery exposed at Faversham. In ordinary dry states of the weather no sign of disturbance could be detected in the section that would indicate an interment. The graves were dug in homogeneous brick earth, with no lines of stratification or bands of pebbles to be broken across, and thus betray disturbance. In wet weather, however, a slight darkening of the moved soil in the graves could be detected.

In the case of a skeleton recently discovered at Barrington by Professor Hughes, as also at Ipswich, no signs of disturbance were noted in the enclosing earth, but in view of the above facts, no importance can be attached to the absence of such signs. Professor Hughes thinks that the clay above the Ipswich skeleton was merely "soil" or "head," and not true boulder-clay at all.

In a letter to the May *Geological Magazine*, Mr. Reid Moir, the discoverer of the Ipswich skeleton, admits the importance of Professor Hughes' observations on the obliteration of all signs of interment in a homogeneous material. He points out, however, that Mr. Slater has apparently changed his opinions, for in a report signed by Mr. Slater and dated October 21st, 1911, there occurs a statement to the effect that the pit in which the bones were found shewed a clear and undisturbed section of weathered boulder-clay, over the calcareous sands in which the remains were partly embedded. He also corrects the statement of the gradient of the plateau to the east of the site, reducing it to twenty-six feet in the half-mile.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended April 13th, as set out in the weekly weather report issued by the Meteorological Office, was at first unsettled, with showers in all districts, and a good deal of snow or sleet in the North. The latter part of the week was generally fine. Temperature was below the average in all districts except Ireland S., and the English Channel, where it was very slightly above the normal. The differences, however, were very slight except in Scotland, N. and E. The highest readings reported were 63° at Oxford and Hereford, on the 7th; with 62° in several places. In Scotland, N., the maximum was only 54°, and in the English Channel 57° was the highest reading reported.

The lowest readings were 20° at Balmoral and West Linton on the 12th, but readings of 26° or less were observed in all districts except in Ireland, where the minimum was 31°, and in the English Channel where it was 40°.

On the grass low readings were reported at many stations, the lowest being 14° at Birmingham and Newton Rigg. At depths of one foot and four feet, however, the temperature was still above the average.

Rainfall was less than usual very generally, but in Scotland E. it was slightly in excess of the normal, while in Scotland, N. it was three times as much as usual. At Glencarron nearly four inches of rain was collected during the week, while at Tottenham and Dungeness the week was rainless.

Sunshine was in excess in Eastern districts, by nearly two hours a day in many places, but in Scotland, N., and in Ireland it was in defect. At Westminster the daily average duration was 5·7 hours (43%). At Yarmouth it was 8·1 hours or 60% per cent.

The sea water was warmer than usual, the means ranging from 42°·1 at Berwick, to 50°·5 at Scilly and Salcombe.

The week ended April 20th was dry and bright generally, but some heavy falls of rain were reported in Ireland on the 20th. A thunderstorm was experienced in Canterbury on the 18th. Temperature had risen considerably, and was above the average in all parts, very considerably so in Scotland. The highest readings reported were 71° at Raunds, and 70° at Lincoln, Hillington, Bawtry and Oxford. Frost was, however, experienced at many stations, the lowest readings being 27° at Marlborough and Llangammarch Wells. In Scotland, N., the lowest reading was 35°, and in Ireland 34°. In the English Channel the temperature did not fall below 41°. On the grass low readings were again reported, the lowest being 20° at

Birmingham and 21° at Ranceby and Wisley. The earth temperature was only slightly above the normal.

The week was very dry, the rainfall being less than the average in all districts except Ireland, S., where it was 0·07 inch in excess. In Scotland, E., the Midland Counties, and England, E., and N.W., no rain was reported at any station throughout the week, and in all parts except in Ireland the amounts collected were very small.

Sunshine, on the other hand, was in excess in all districts except Ireland, N. In Jersey the amount registered amounted to a daily average of 10·7 hours or 78 per cent. of its possible duration.

In Westminster the value was 6·3 hours per day, 45 per cent., while at Brighton it was 9·0 hours (65%).

The sea temperature varied from 42° at Berwick to 55° at Ballintrae.

The weather of the week ended April 27th continued very fine as a whole, although some rain fell in Ireland and Scotland early in the week, and thunderstorms were reported from Ireland towards the end of the period. Temperature was still above the average in all districts, and as a rule to a considerable extent. Readings of 70° or upwards were reported in all the districts except Ireland, N., the highest readings being 72° at at Tottenham and Bawtry. Readings below freezing point were observed in two districts only, Scotland, E., and England, S.E., the minima being 29° at Balmoral and West Linton, and 30° at Marlborough. The temperature at depths of one foot and four feet below the surface was again above the average.

Rainfall was extremely slight. In England, E., and the Midland Counties the week was rainless at each station for the second week in succession.

In England S.W., also, no rain was reported. In all the districts there were some stations at which no rain fell during the week.

Bright sunshine was in excess in all districts without exception. In six of the districts the daily average exceeded 10 hours the maximum value being 11·3 hours in England, S.E., or 79 per cent. of the possible duration.

The South Coast of England was extraordinarily sunny and while Worthing, Ventnor and Bournemouth each reported a daily average of 12·0 hours (85%), Portsmouth had 12·1 hours (86%) and Hastings 12·3 hours (87%). At Westminster the daily average was 10·8 hours (76%).

The temperature of the sea water round the coasts was still above the normal, the mean values ranging from 43°·4 at Berwick to 53°·2 at Plymouth.

The weather of the week ended May 4th was dry at first, but towards the end of the week welcome showers were experienced in most districts. Temperature was not far from the normal except in Ireland and the English Channel where it was somewhat in excess. The highest readings reported during the week were 70° at Tottenham and 69° at Marchmont, on May 2nd. The minimum were below the freezing point in every district except the English Channel. The lowest readings were 24° at Llangammarch Wells, and 26° at Marlborough on the 30th April. On the grass the lowest readings were 16° at Newton Rigg and 17° at Wisley. The temperature of the soil at one foot and at four feet continued above the average in all districts.

Rainfall was less than the average in all districts, and at Durham, Tunbridge Wells and Ventnor the week was rainless. In the English Channel the value for the week was only 0·05 inches, as compared with an average over twenty-five years of 0·45 inches, or one-ninth of the usual amount.

Bright sunshine was in defect as a rule, but in Scotland, N. it was more than the average by 0·3 hours a day, and in Scotland, W. it was normal. The sunniest district was the English Channel with a daily average of 7·5 hours (52%). In Scotland, E. and the Midland Counties the average daily amount was only 3·5 hours. In Westminster the daily mean was 4·8 hours (33%).

The sea temperature was again higher than usual, and the mean values ranged from 44°·0 at Berwick to 54°·8 at Scilly.

The week ended May 11th was very unusually warm, with light rainfall and scanty sunshine. Thunderstorms occurred on several days, and much fog was observed round our West and South coasts.

Temperature was above the average in all districts, the excess amounting to 9° in England, E., where maxima of 82° were observed on the 11th at Cromer, Norwich, Geldeston and Cambridge.

The highest reading reported was 83° at Greenwich, also on the 11th. Readings of 81° were recorded at Yarmouth, Raunds, and Camden Square. On the other hand, in Scotland, W., the maximum was only 64°. The lowest reading for the week was 31° at Strathpeffer, on the 5th, but at no other station was frost observed at four feet above the ground.

In more than half the districts no readings below 40° were reported, and in the English Channel the minimum was 47°. Sharp night frosts on the ground were observed, the lowest readings being 25° at Crathes and 27° at Birmingham. The temperature of the soil was still above the normal.

Rainfall was above the average in Scotland and in England, S.W., but was below elsewhere, except in the English Channel where it was normal. In Scotland, N., the amount was more than double the average and at Lerwick the total for the week exceeded two and a half inches.

Sunshine was deficient at every station except Aberdeen. In England, S.W., the mean value was 1·2 hours per day, or 5·6 hours below the average. At Aberdovey, Aberystwyth and Pembroke the duration was less than half an hour per day. At Westminster the mean for the week was 3·8 hours per day, or 25 per cent. of the possible duration. The sunniest station was Felixstowe with a daily average of 6·6 hours (44%).

The temperature of the sea water was still above the average, and the means ranged from 45°·2 at Berwick to 55°·2 at Plymouth.

RAINFALL OF APRIL. The rainfall of April, 1912, was remarkable. In the West of Scotland the month was exceptionally wet, some places reporting totals of upwards of 10 inches. The East of Scotland on the other hand was very dry having less than one inch for the most part, less than half an inch round the coast south of Aberdeen, and less than 0·1 inch round the Firth of Tay. In Ireland the totals were not far from the average, but in England and Wales the month proved to be the driest April on record. At Camden Square Dr. H. R. Mill, of the British Rainfall Organization, recorded only 0·04 inches which was the lowest amount collected there in April since the record began in 1858. With one exception February, 1891, 0·01 inch, it was the lowest monthly total of that long series. Rainfall records are available at one or more London stations from 1781, and during this period of one hundred and thirty-two years only two Aprils (1817 and 1840) had less than 0·10 inch of rain, and these had 0·06 inches in each case.

Of twenty very dry Aprils it has been noted that in nineteen cases the following July was also very dry. It will be interesting to note if this sequence holds good in 1912, and if July this year is exceptionally dry in England and Wales.

During a kite ascent at Brighton, carried out under the direction of Mr. S. H. R. Salmon on May 11th, a remarkable rise of temperature with increase of height was observed. At the ground level the temperature of the air was 55°, but at a height of three thousand feet, instead of the usual fall of about 10°, there was a rise of 20° registered.

ECLIPSE OF THE SUN. Observations taken at Greenwich during the Solar Eclipse on April 17th showed that the temperature of the air fell from 58°·2 at 10.55 a.m. to 52°·0 at 0.20 p.m., and rose again to 56°·7 at 1.45 p.m. The solar radiation as recorded by a black bulb thermometer fell from 104°·0 at 11.2 a.m. to 56°·8 at 0.20 p.m., and rose again to 101°·9 at 1.43 p.m.

MICROSCOPY.

By F.R.M.S.

INSECTS' EGGS have long been favourite low power objects with microscopists on account of their beautiful forms and delicate markings. Illustrations of a great many have been published in works devoted to entomology and microscopy,

[illegible]

H[illegible] [illegible] produ[illegible] of [illegible]. In colour they are a dark [illegible] with a finely granulated surface [illegible] each egg also has upon one [illegible] form in outline bordered with a dark [illegible] probably representing the point at [illegible] attached to the ovary. In shape they [illegible] measuring ·10 inch by ·07-inch, the [illegible] slightly flattened and fitted with an [illegible] cover [illegible] by ·04 inch, on the top of which is a bright yellow knob, circular in shape with a diameter of

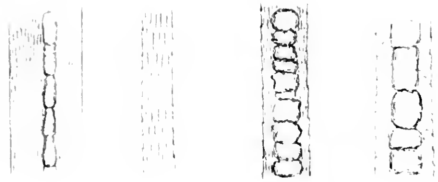


FIGURE 262.

[illegible] Large coloured hair with small medullary cells.

[illegible] A flat, coloured hair, strongly fibrous, with no medullary cells.

[illegible] Coloured hair with large medullary cells.

D. Colourless hair with large medullary cells and sheathing cortical cells.

·03 inch and ·01-inch high, looking under the microscope not unlike the lid of a brown earthenware teapot. The upper surface of the cover is formed of hard material uniform with the shell of the egg, but below this is a thick layer of rather softer substance, darker in colour and finely toothed round the edge, the teeth fitting accurately into corresponding corrugations round the thickened edge of the opening, whilst below this again is a layer of stout white membrane similar to that with which the egg itself is lined. The knob has a deep depression in the centre, a section through which seems to show that at one time there was a perforation through this leading to the interior of the egg, probably in the nature of a micropyle. The use of the knob is not very obvious, as the larva when mature pushes off the cover from the inside, causing it to fall intact, but in escaping from the egg it frequently happens that the claws of one or both of the third pair of feet become so entangled in the lining membrane as to oblige the young insect to drag the empty egg shell about with it until artificially relieved. The larva when first hatched is so much larger than it seems possible for the egg to have contained that it is very probable the segments of which the body is composed may overlap each other before emergence, and the [illegible] increase in size after changing the skin is perhaps due to a similar cause. The eggs are laid separately, and are not attached in any way either to each other or to the [illegible] where they are deposited, the period at which they [illegible] quite uncertain, as it takes place at all times of the year and apparently not much affected by the temperature of the [illegible] the young larva resembles the parent except as to [illegible] absence of wings. It has been said that these insects will [illegible] devour those of their own species, but although [illegible] not been conclusively proved against them, it may [illegible] account for the otherwise mysterious disappearance [illegible] small specimens from a box in which [illegible] kept together. R. [illegible]

WHAT IS WOOL? [illegible] which I have [illegible] of this note is a cause [illegible] Textile fibres [illegible] both of [illegible] and animal origin, have been in use from time [illegible] and have been [illegible] studied in every [illegible] optical, chemical, physical [illegible], that the mere [illegible] to there being any doubt as to the definition of *wool* [illegible] to many unthinkable. There can be no doubt that wool, [illegible] one of the best [illegible] and most widely used [illegible] also one of the very first to be used by man to protect himself from the inclemencies of the weather, following, indeed, very closely upon his first tentative, but unsatisfactory, [illegible] in this direction. One's first thought is, very naturally, that *wool* is the hair of the sheep, as we are constantly reading of vast quantities of this commodity being imported from Australia, where sheep farming for the sake of the wool is the chief industry. This is, however, far from being the last word on the subject; for if we make the necessary enquiries we shall discover that commercially, at all events, the term *wool* is not solely confined to the product of the sheep. Hairs from several animals are described as being *wool*, no doubt from their having characteristics similar to those from the sheep. I need here only mention that the hairs of several species of goat, such as the Alpaca, Angora and Cashmere, are invariably designated *wool*; as are also the hairs of the llama and camel. Indeed, there can be little doubt but that many animals would furnish hairs which most microscopists would characterise as *wool*. Failing some authoritative decision on the point, it would appear that we can only fall back on the physical and microscopical characteristics of the fibre. In this connection it must not be forgotten that even the hairs of the sheep differ within fairly wide limits according to climatic and other conditions, the principal of which, no doubt, would be the breed of the sheep. Some of the larger and stouter show strongly marked medullary cells, with the overlapping cortical scales but weakly developed, while in the finer fibres there is an entire absence of the central, but the cortical cells are strongly developed. In what is recognised as the best wool from the sheep, a careful examination will show that the hairs have a soft, slender, wavy appearance, and microscopically the medullary, or central cells, are either absent or at least not strongly marked, while the cortical cells are well-

FIGURE 263.

E. Colourless hair with smaller medullary cells and well-marked cortical cells.

F. Large colourless hair with no central cells, but with fine and close cortical cells.

G. Fine hair with well marked sheathing cortical cells.

H. Fine hair, similar to the last, but with finer cortical cells.

developed as sheathing scales, overlapping each other so as to give a finely-serrated appearance to the margin of the filament, and an appearance of fine, sinuous lines crossing the fibre. Any hairs having these characteristics would unhesitatingly be pronounced *wool* by most microscopists, and from a histological standpoint, they would be fully justified. There can, however, be little doubt that whenever the term wool is used in a commercial sense, without any qualification, the hair of the sheep is invariably meant. In an earlier part of this note, it was suggested that many animals on some parts of their bodies would furnish hairs with a very decided wool-like structure, which, if submitted to a microscopist, would be designated *wool*. It is one of the commonplaces of knowledge, that the hairs of most, if not of all, animals differ very materially, according to the part of the body from which they are taken; those from the exposed surfaces being usually coarser, while those from the under parts are invariably finer and softer, and it is a well-established fact that many of the latter have a strongly-marked wool-like structure. I know of no animal which exhibits the difference in the character of the hairs from different parts of the body in so striking a degree as the Hedgehog (*Erinaceus europaeus*), for in that animal we have a gradation from stout spines to the softest and finest hairs, and the histological structure is equally varied. There is, however, another animal, much more familiar to us, which exhibits a similar wealth of variety in the structure of the hairs from different parts of the body, and the drawings of the hairs of the cow which are given as illustrations (see Figures 262 and 263), will fully bear out this contention. There we have gradation in a remarkable degree, as there are large coarse hairs with strongly marked medullary cells, but with very slight indications of the overlapping cortical cells, through others in which there is a gradual diminution of the former structure and a corresponding increase in the latter, until finally we arrive at those showing the full characteristic structure of the wool. From the article "Wool" in the "Encyclopaedia Britannica," I quote the following, which states the case very succinctly—"At what point, indeed, it can be said that an animal fibre ceases to be hair and becomes wool, it is impossible to determine, because in every characteristic the one class by imperceptible gradations merges into the other, so that a continuous chain can be found from the finest and softest merino to the rigid bristles of the wild boar." It might be thought that the question had an academic interest merely, but such is not the case; circumstances have been brought to my notice which prove that it is also of some commercial importance. Some time ago, one of our largest manufacturers of felt submitted to me a sample for microscopical examination. He had previously contracted to supply to a German merchant, a felt *free from wool*, as the tariff on all goods containing wool was absolutely prohibitive. On arrival at the German port, it was examined by the experts of the revenue authorities and refused admittance except on the higher scale, on the ground that it contained wool. Then ensued a deadlock, as the merchant refused to accept delivery on what, to him, would have been prohibitive terms. It was a sample of this felt which was submitted to me, after having been sent to a Liverpool analyst, who suggested that it was rather a matter for a microscopical specialist than for a chemical analyst. It was submitted with an assurance that no wool had been used in its manufacture. On examination, it was composed, according to my view, of cow's hair and jute with a small percentage of flax and *wool*. A report was given to this effect, which, of course, was unsatisfactory, as one was desired certifying to the total absence of wool. Shortly afterwards, another sample was submitted, the materials of which had been mixed under the close personal supervision of the head of the firm, who gave me his word of honour that absolutely no wool had been used in the making of that particular sample of felt. Again wool was found, roughly to the extent of about four or five per cent. This was inexplicable, and I was assured that there must have been a mistake somewhere, and a delicate hint was given that it could hardly have occurred at their works. Separate samples of the materials used in its manufacture were then asked for, and in the cow's hair was found what was unhesitatingly pronounced to be *wool*, and it was suggested that this was probably the source of contamination and the explanation of the apparent discrepancy. I was assured, however, that no admixture of wool had taken place at their works, and that the considerably higher price of wool (at least four times the price of cowhair) was a sufficient guarantee for the honesty of the merchant from whom the cowhair had been purchased. The matter could hardly be allowed to rest here; for, not to mention one's reputation, which it was evident had suffered some diminution, there was still no explanation forthcoming as to the undoubted presence of wool, and my interest being by this time thoroughly aroused, I could not be content without following the matter up until a solution of the difficulty should be arrived at. On thinking the matter over, I determined to procure hairs from different parts of the cow direct, with the satisfactory result that from various parts, but especially from the flank, I was both astonished and delighted to find that a considerable proportion of the hairs had all the characteristics of sheep's wool. To fortify my own dictum, I sent off specimens of this wool-like cow's hair to several friends who are experienced microscopists, one of whom undertakes chemical and microscopical analyses for commercial men, and in every case it was unhesitatingly pronounced to be *wool*. I am not aware that the fact has been previously noted, and as the matter appears now to have some commercial, as well as a scientific, interest, this record may be considered as not without some value. It is also gratifying to note that the German revenue authorities, on the result of this modest piece of research being submitted to them, have intimated that similar qualities of felt will now be admitted free, if accompanied by an affidavit to the effect that there has been no addition of sheep's wool. As a result, several consignments have been made on this undertaking, and although on one or two occasions there has been some correspondence, the arrangement, I believe, still continues. It would appear from this that our German friends are now willing to consider that wool-like hairs, if not from the sheep, are not *wool*, but they may readily be excused, I think, if the practice gets commoner, or if our manufacturers should utilise other animal hairs of a somewhat similar character, if, for revenue purposes at all events, they should revise their definition and insist that all wool-like hairs, from whatever source, are *wool*.

J. E. Lord.

THE PREPARATION OF SNAILS' TONGUES FOR THE MICROSCOPE. Every snail, and almost every mollusc (except the Pelecypoda), bears upon its tongue a number of symmetrically-arranged rows of teeth, with which the food is rasped into a form convenient for ingestion. These teeth are generally hook-like in form, whence they are called unci. There is a central row, seen in the embryo of *Physa* to be formed by the coalition of two side rows; and the rows which border upon the central row are generally of a different type to the outer ones, so that there is a more or less clear differentiation into admedian and external rows. It would have been in accordance with the rules of anatomical nomenclature to call the outer rows lateral, rather than external; but unfortunately many authors have used the term lateral for the admedians. In the case of *Physa*, which we have some reason for calling a very primitive form, there are no admedians, and all the unci are pectinated. This pectination is less regular in Limnaeids; in *Succinea* and the Helices it undergoes a peculiar modification; in the Arions (perhaps derived from the Helicid stock) it is nearly lost; while it undergoes a different kind of modification in *Vitrina* and *Limax*, and in *Zonites* only appears as a teratological reversion. In *Testacella* it is not found at all. Indications are thus supplied from which a classification of the Pulmonates may be sketched out; and into such a classification the other anatomical characters appear to fit very well. It has been objected that the nature of the food of the species determines the type of radula. I believe that this may very well be the case, but that the nature of the food is itself a most important evolutionary factor; that changes in this respect are likely to be slow and not abrupt; and that the whole of the organism, including the reproductive and tegumentary organs, will have reacted in harmony with such changes. According to this view the main evolutionary changes have been brought about by what is ultimately a chemical factor; while there is much reason for supposing that many useful and decorative modifications may have originated in sudden mutations, and it seems likely that if we could more fully examine these mutations, we might set them down as due to physical factors. In the last resort no doubt it would be impossible to distinguish between the chemical and the physical; but still it appears a plausible view that changes depending upon factors of a smaller order should be slow and fundamental, while changes depending upon larger and compound factors might be more

[illegible]

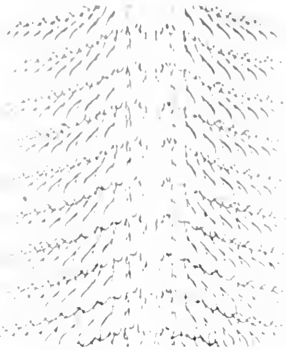


FIGURE 264.

Radula of *Zonites scharffi* Kennard. In paraffin.

[illegible] points, starting with the snails' tongues as text, since circumstances do not permit me to pursue the matter at present, it seems well to thus lay the skeleton of my [illegible] before the readers of "KNOWLEDGE." There is another very interesting point that is brought out by the comparative [illegible] of radulae. There are strong indications that the inter-relationship of all these molluscs is in reality much closer than systematists would be inclined to allow. Science is description, and much of it has become very minute description; but it may be that in the near future more energy will be expended on the study of possible evolutionary factors [illegible] careful search for (unexplained) specific differences [illegible] the construction of elaborately artificial classifications. These remarks may tend to show that the snail's tongue offers a fertile field for investigation to the microscopist

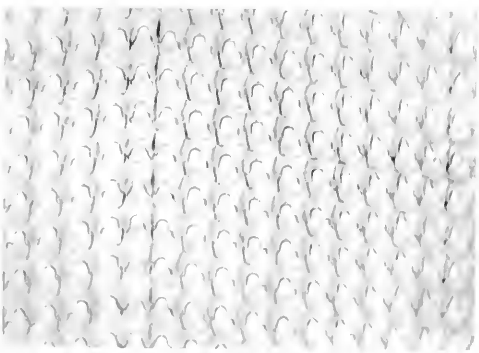


FIGURE 265.

Radula of *Helix fusca* Mont. In paraffin; small aperture.

[illegible] in favour of beautiful objects, and at the same [illegible] preference for a line of study which may have [illegible] bearing upon questions of scientific philosophy. [illegible] object of this note is to point out the interest of the [illegible] describe a method of making permanent preparations [illegible] the result of many years of experiment. There are [illegible] other microscopical objects to which the same [illegible] apply.

[illegible] practical question to decide is whether the structure [illegible] are to be rendered visible by differences of [illegible] by [illegible] in other words whether [illegible] to deal with them [illegible] as unstained objects. [illegible] often made that these two methods should [illegible] combined, so that one has a stained object mounted in a medium of refractive index higher or lower than its own. Let [illegible] *Limnaea stagnalis* be stained with carbol fuchsin and mounted in monobromide styrax; or let an ordinary stained [illegible] be mounted in some [illegible] medium of lower refractive index than Canada balsam. The result is that one has a preparation that can be examined as a stained object, and also as an unstained one; and if in any case it is important to be able to change from one style to the other by the simple means of opening and shutting the iris of the condenser, this combination may be desirable; but it must be added that the specimen which has these double properties is not so good for either purpose singly as the specimen specially mounted for observation in one or other of the two ways. It may be noticed here that if a specimen is to be examined with polarised light or by dark-ground illumination, the visibility of its details may generally be augmented by staining it with a fluorescent stain. This looks as if the stain was merely adsorbed, and had no chemical reaction with the tissue.

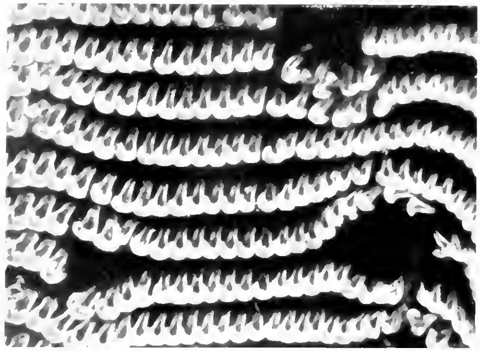


FIGURE 266.

Radula of *Succinea elegans* Risso. In paraffin. Zeiss dark ground condenser.

With objects mounted for refraction contrast, the actual numerical aperture has a distinct influence on the formation of the image by contrast of refraction, according to the angle of delivery of the rays. A radula in paraffin, for example, may be clearly seen as a black object with a very low power, having condenser and objective equally balanced; contrast sufficient to show details may be evident when this is exchanged for an objective of N.A. ·20, the condenser being opened to match; exchanging further for an objective of N.A. ·30, and again matching, the outlines seem inclined to disappear, though what you do see is very sharp; but when you get to N.A. ·85 it may be impossible to see anything by contrast without shutting down the condenser iris. However, the phenomenon does not stop there, for if now you exchange for an oil immersion of N.A. 1·30, you will again see the contrast image, without any shutting down of the condenser aperture, this being made equal to that of the objective by the usual means. On the other hand, the improvement in definition obtained by using objectives of higher numerical aperture on stained objects in a homogeneous medium, is progressive and continuous, the entire aperture being used. Here, obviously, it is not possible to improve definition by any closing of the iris; where this plan appears to give improvement, it is due either to contrast effect obtained between two elements of the preparation which do not happen to be of exactly the same refractive index, or to a deficiency in the objective, which ought to have been provided with a smaller internal diaphragm.

Any microscopist who will critically examine radulae or other small objects in various media can confirm these statements. Air, water, salt solution, glycerin in various dilutions, chloral hydrate mixtures, glycerin jelly, paraffin, dammar, colophonium, bergamot oil or turpentine dilutions of these last two, serve to exemplify media of low refractive index; of these I have found paraffin (as recommended by Dr. Coles, "KNOWLEDGE," Vol. XXXIV, page 192) to be by far the best, and glycerin jelly by far the worst, on account of its instability, the action which (as an aqueous medium) it has upon the glass, its want of transparency, and the difficulty with which it is removed from the object when it is desired to remount. Of media possessing higher indices than balsam, I have tried styrax, styrax in monobromide of naphthalin, the monobromide alone, and methylene diiodide. These are optically better, on the ground that they give better definition in depth, which is often greatly desired in photography; but for ordinary use they are ineligible, the best being the monobromide styrax, which, however, has the grave disadvantage of depositing gum after a time, besides undergoing a change not yet sufficiently investigated. I recommend that objects to be viewed by contrast shall be well dehydrated and brought into paraffin. If no more than the requisite amount of paraffin be used, there is no need to secure the cover. Paraffinum liquidum, not fluorescent, can be obtained of any chemist. If remounting is necessary, it is perfectly easy to wash the preparation in xylol, when it may be treated in any of the usual ways. Mounting in paraffin is thus extremely simple and good as a temporary method. The liquid penetrates a dehydrated specimen with great ease, and remains unchanged. To complete the dehydration of larger specimens it is well to clear with creosote or clove oil. Paraffin specimens are best for photographic purposes.

FIGURE 267.

A photo-micrograph of a living Crustacean (*Cyclops*) taken with the camera seen in Figure 268. Exposure half-a-second.

In accordance with the considerations adduced above, the definitive method will consist in mounting the specimen, after staining, in Canada balsam. Now, therefore, it only remains to describe the staining. A radula boiled out in caustic alkali will be already fixed to some extent. Almost any stain will now colour the newly-formed end of the organ. The rest of the structure will not stain regularly with any reagent. It will do so, however, and in a definite way, after a second fixation, or mordanting. Any of the usual histological fixatives may be used, or plain solutions of potassium bichromate, permanganate, or iodine. Tincture of iodine gives very good results, and should be applied for such a time that after washing out with absolute alcohol the structure is still distinctly stained yellow. Stain next with Biebrich Scarlet until the basal-plates throughout are strongly coloured. Remove superfluous stain with cigarette paper, and wash in absolute alcohol until no more stain comes away; a drop or two will suffice for this purpose. The newly-formed unci will now be seen coloured a brilliant red, and the basal plates throughout with a duller red; this colour is fast. Wash again with distilled water, and stain for some time in an aqueous solution of thionin; this will not affect the parts already stained, but will clearly colour the points or pectinated parts of the unci. The preparation so made shows all the detail that is desired; there is no uncertainty about any part of it, and optical illusions are reduced to a minimum. You may focus through the specimen and thus optically dissect it.

It is perhaps desirable that some other stain should take the place of thionin, which might be fugitive in Canada balsam. But in this case, perhaps, the thionin has formed a compound with the iodine; it is certainly dislodged less easily than from sections. In any case, it is probable that a substitute of undoubted permanence could be found. Mordanted specimens may also be stained with Kernschwarz, when they can be photographed. A balsam specimen stained ten years ago in gentian violet is still as good as ever; but it will be noticed that the particular object of the Biebrich scarlet and thionin succession is to provide a selective staining of different elements. For this it is necessary that the first stain should colour only new-formed unci and basal-plates, and that the second stain should form no compound colour with the first, nor wash it out. It is plainly impossible to represent the contrasting colours by simple photographic methods, but they serve most materially to elucidate the structure. Radulae fixed in bichromate may be stained yellow with osmic acid; this yellow colour may be "developed" to black by means of pyrogallol. This method, originally suggested by Bolles Lee in 1887, gives most excellent results with radulae which show but small basal-plates. It is probably the best method for Pectinibranchs.

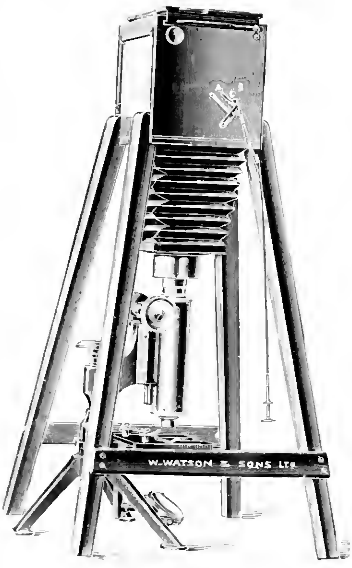


FIGURE 268.

A new instantaneous photo-micrographic Camera.

Radulae can be fixed to the glass of the slide by covering them with a drop of bichromate when they have been arranged on the slide, and allowing it to soak well into them (two or three minutes). This must be done by dim or red light. Now cover and expose the back of the slide to sunlight, so as to cause the formation of the insoluble chrome compound in the membrane. Drain off the superfluous liquid and leave to dry. On subsequent washing the specimens should be found well fixed, in both senses. The cover used in this process may be another slide tied on the first, and a thin film of paraffin on its inner surface prevents the front of the radula from sticking to the cover.

The image-erecting dissecting microscope with Porro prisms is of the greatest value for dissecting out radulae and in all mounting processes.

E. W. BOWELL.

A NEW INSTANTANEOUS PHOTO-MICROGRAPHIC CAMERA.—At the meeting of the Royal Microscopical Society, held on April 17th, Mr. F. Watson Baker exhibited a new reflex photo-micrographic camera for the instantaneous [illegible] open [illegible] of [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] we owe to [illegible] Messrs. W. Watson & Sons [illegible], [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the image of the [illegible] [illegible] round [illegible] [illegible] on the left [illegible] [illegible]. The shutter at the dark slide can be [illegible] [illegible] [illegible] [illegible]. When the release is [illegible] the [illegible] [illegible] the screen and the exposure is [illegible] terminated by the falling of a flap. The exposure [illegible] be made very short if desired, but as a rule in practice it [illegible] one or two seconds. The photograph which is reproduced in Figure 267 was taken on an Imperial Rapid Plate and the exposure was half a second, the light [illegible] [illegible] from a Duplex oil lamp. To set the shutter [illegible] [illegible], it is manipulated in the ordinary way and then [illegible] [illegible] C, shown in Figure 268, is turned so that it [illegible] [illegible] to B. On pressing the release, the shutter is [illegible] and will remain so until the lever is brought back to A. [illegible] [illegible] be obvious that this excellent little camera can be [illegible] many occasions where there is no need for instantaneous [illegible], and it will be a convenience to those who are accustomed to use an ordinary camera that the focusing screen is vertical. Messrs. Watson & Sons are to be congratulated on the production of this simple, effective, and compact piece of apparatus.

QUEKETT MICROSCOPICAL CLUB.—On April 23rd, Mr. A. W. Stokes exhibited and described several methods of adapting electric lighting to microscope illumination. In one case the lamp, enclosed in a metal tube open at one end, was fixed to an adjustable arm attached to the stand. When once focussed on the object it remains so. If an ordinary supply of current was not available, the use of small pocket batteries was recommended. These gave four hours' light at a cost of fourpence, and the cell was easily renewed.

John Stevens, F.R.M.S., read "A note on *Notommata gigantea* Glascott." This rotifer, a true parasite, is only found in the ova of water-snails, and the communication was a series of notes of observations made in June, 1911.

Dr. Duncan J. Reid discussed "Illumination in critical work with the microscope." The subject was treated under the following heads: The most suitable light, collecting lenses, the principles of correct illumination (*a*), as regards the field and (*b*), filling of the objective with light, condensers, distance of lamp from mirror, critical and non-critical illumination, working aperture and general arrangement of light and apparatus in high, medium, and low power work.

C. D. Soar, F.R.M.S., exhibited coloured figures of the fifty species of *Arrhenurus* recorded in the British Isles.

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

WINTER MOVEMENTS OF THE GANNET IN THE OUTER HEBRIDES.—Mr. Robert Clyne, lightkeeper at the Butt of Lewis, in a recent article in *The Glasgow Herald* has given a vivid sketch of the movements of this great bird "midst furthest Hebrides." He writes: "Gannets are never altogether absent from our shores, though they are rarely seen during the three winter months. Borne west and north by south-east gales, they were seen by mid-February passing the Butt of Lewis, flying out into the North Atlantic, having been absent from the locality for only a few weeks. Their annual extraordinary procession up the Minch, round the north of Lewis, and out in a south-westerly direction to their breeding haunts—St. Kilda principally—is not due until about the middle of March. At the Butt of Lewis they all appear as coming up the Minch, but doubtless the majority will collect from the North Sea, rounding Cape Wrath, keeping well, as is their habit, to the contour of the land, till near the Lewis coast they converge with others into one continuous stream. Hugging the land at the extreme north end of the Lewis, many pass through a narrow channel—a veritable gannet highway, for over it flocks pass all summer going to and from their feeding grounds."

SUCCESSFUL PROTECTION OF BIRDS.—We gather the following satisfactory items from the recently issued Annual Report for the year 1911 of the Royal Society for the Protection of Birds. At one of the few remaining breeding places [illegible] [illegible], eleven pairs were seen instead of only three pairs, as was the case when the work of protection by a watcher was started; and in the Shetland Islands the Great Skua had increased largely in numbers, while Richardson's Skuas were now plentiful (Mr. E. G. B. Meade-Waldo). There were now at least eight pairs of Kites where nine years ago only two pairs and an odd bird existed. In a certain area in the same period of time, Buzzards are estimated to have increased from forty pairs to seventy pairs. Ravens had done exceedingly well, and Barn Owls were again becoming numerous (Rev. D. Edmunds Owen). An extraordinary increase in the winter flocks of Goldfinches and Siskins in Scotland was reported by Sir Herbert Maxwell.

ARRIVAL OF SUMMER BIRDS: A COMPARISON. The following list gives the dates of the arrival of some of our earliest summer visitants up to the end of April this year. The English dates are mostly from the columns of *The Field* and the Scottish ones are from a report made by Mr. John Paterson to the Natural History Society of Glasgow. The list is confined to birds occurring in both districts, and therefore many kinds known in England are not included in it. In a general way it confirms what is known as to the differences consequent upon the geographical situation of the two districts, but reports the White Wagtail and Corncrake are earlier in the North than in the South.

	West or South of England	West of Scotland.
Chiffchaff	10th March	14th April
Wheatear	18th „	1st „
Whinchat	26th „	26th „
Sand Martin	27th „	5th „
Ring-Ouzel	29th „ (Windermere)	26th „
Swallow	30th „	12th „
Yellow Wagtail ...	1st April	19th „
Cuckoo	6th „	18th „
Willow-Wren	6th „	15th „
Common Sand-piper	7th „	11th „
White Wagtail ...	10th „	5th „
Tree-Pipit	14th „	23rd „
Wood-Wren	23rd „	28th „
Corncrake (Land-rail	23rd „ (Co. Mayo) ...	19th „
Swift	26th „	28th „

NEW LIST OF BRITISH BIRDS.—Messrs. Witherby & Co. have just published "A Hand List of British Birds," giving a detailed account of the distribution of each bird in the British Isles, and a general account of its range abroad, together with details of the occurrences of rare species. The Hand List is the joint work of Messrs. E. Hartert, F. C. R. Jourdain, N. F. Ticehurst, and H. F. Witherby.

PHOTOGRAPHY.

By Edgar Senior.

EXPOSURE TABLE FOR JUNE.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and lens aperture F.16.

Day of the Month	Condition of the Light	Time of Day: 10 a.m. and 2 p.m.	8 a.m. and 4 p.m.	6 a.m. & 6 p.m.	5 a.m. and 7 p.m.
June 1st	Bright	09 sec	12 sec	24 sec	48 sec
„ „	Dull	18 „	24 „	48 „	96 „
June 15th	Bright	09 sec	12 sec	24 sec	43 sec
„ „	Dull	18 „	24 „	48 „	87 „
June 30th	Bright	09 sec	12 sec	24 sec	43 sec
„ „	Dull	18 „	24 „	48 „	87 „

Remarks.—If the subject be a general open landscape take half the exposures given here.

PHOTOGRAPHY WITH A MICROSCOPE.—Photography from quite an early period of its existence appears to have been employed to secure images of microscopic objects, for we find it stated that Wedgewood and Davey in 1802 obtained photographic records by means of the solar microscope, employing paper rendered sensitive to light by treatment with a solution of silver nitrate. They found that images of small objects could be produced without difficulty in this way. Thus, among the very first experiments in photography was the aid of the microscope sought as a means for forming images intended to be photographed. Although so early in the field, photography with the microscope (photo-micrography) can scarcely lay claim to have been the most successful of the many branches of photography. This may be traced to several causes. In the first place a microscope is primarily intended for use as an instrument for visual observations only, therefore its objectives and eyepieces have naturally been constructed to give the best results when employed in this manner. Such being the case those rays which are of such prime importance in photography are left outstanding, or in other words, are not united at the same focus as they are in the case of a photographic objective, with the result that a picture, sharp visually, would be wanting in definition when photographed, owing to chromatic differences of focus. Further, the great majority of objects have to be illuminated by transmitted, instead of reflected light, and the shortness of focus of the lenses, together with their smallness, renders the proper illumination of the objects anything but an easy matter, and this, together with the want of sharpness over the entire field "with any except low powers," has contributed to make photo-micrography less successful than is ordinary photography. So much attention, however, has been given to the subject of late years, that, what with the great improvements made in the construction of objectives, and the use of orthochromatic plates, and suitable light filters, excellent results can now be obtained with ordinary achromatic objectives, while the apochromats and projection oculars place in the hands of those, not specially skilled, a means of obtaining good results with comparative ease. The problem of illumination, too, has received so much attention from skilled microscopists, that many of the former troubles no longer exist.

FIGURE 269. A Rose Beetle. × 10 diameters. Photographed with a Zeiss Planar series I A No. 5. 100 mm. focus stopped down to F16.

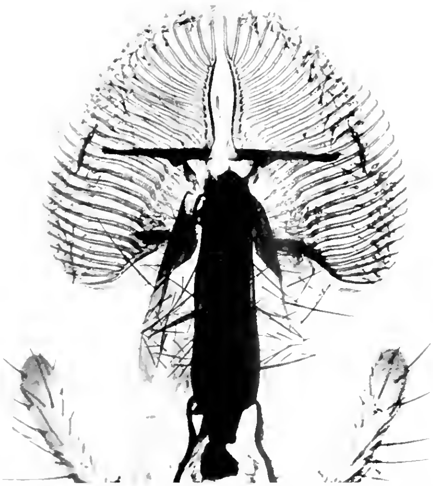


FIGURE 270. The Proboscis of a Blow Fly. × 40 diameters. Photographed with Messrs. James Swift and Son's 1-inch objective without eyepiece.

PHOTO-MICROGRAPHS AT A LOW MAGNIFICATION.—Many large transparent objects, insects, and so on, require to be photographed so as to show the entire specimen. These must be taken at a low magnification, and an objective employed which has a field sufficiently large to include the whole of the object, and in order to ensure successful results attention must be given to obtaining as uniform a lighting as possible. The illustration (Figure 269) is from an object photographed under the conditions necessary to include the whole of the specimen, and was taken with a Zeiss planar of one-hundred millimetres focus. This objective was screwed into the end of a conical tube and attached to the body of a Zeiss photo-micrographic stand, from which the draw tube had been removed. The source of light was a thirty-ampere arc lamp. To collect the light, a plano-convex condenser was placed in such a position that the emergent rays were rendered parallel. A second lens of shorter focus was then placed in the path of this beam, by means of which the light was made to converge, and fall upon a simple spectacle lens condenser placed in the sub-stage. By this means a uniformly-lit field was obtained, and by careful manipulation of an iris diaphragm placed in the path of the parallel beam, all light not required was excluded. On placing the specimen on the stage and focussing, a brilliant image on a perfectly evenly illuminated field was the result. A green screen was employed to give the necessary contrast, and an exposure of five seconds given, using an Imperial N. F. plate of speed two-hundred H. and D., the developer being Pyro-soda. In photographing the example shown in Figure 270, while the same general arrangement for illumination was retained the objective employed was a one-inch made by Messrs. James Swift and Son, of Tottenham Court Road. This was screwed into the lower end of the microscope, the light conical adapter still occupying the place of draw tube, which had been removed in order to avoid any internal reflections as well as restriction of field of view. In any case, when photographing without an eyepiece, if the draw-tube remains in position its end must be lined with black velvet to avoid these reflections. After carefully focussing the source of light, a perfectly illuminated field was obtained. The specimen was then placed upon the stage and focussed for those hairs which form the distinctive feature of the [illegible] The [illegible] of the [illegible] plate [illegible] extension was one hundred and sixty-three centimetres. A [illegible] twenty seconds [illegible] on an Imperial N.F. plate of speed two hundred and twenty-five H. and D. The negative was developed with [illegible] developer. The two examples accompanying this article are from negatives taken at the first of the series of practical demonstrations on photo-micrography given at the South Western Polytechnic on Monday, May 6th, and must not be regarded as the best that could be obtained, as much more time could be spent in the adjustment of apparatus than is possible when demonstrating before a class. They are, however, good, and serve their purpose perfectly, in illustrating as they do the application of photography in low power photo-micrography.

PHYSICS.

By Alfred C. G. Egerton, B.Sc.

ACTIVE NITROGEN.—In the *Proceedings of the Royal Society* are to be found further accounts of Professor Strutt's experiments on "active" nitrogen. It appears that "active" nitrogen is nitrogen in the atomic condition, and not polymerised as oxygen is in ozone (O_3). Oxygen destroys the nitrogen glow; which glow appears to be the luminosity afforded by the process of passing from active to ordinary nitrogen, or in other words, to combination of nitrogen atoms. The oxygen does not appear to actually combine with the nitrogen, but acts as a catalyst and hurries the production of ordinary nitrogen. One very important result is that active nitrogen appears to play no part in the production of oxides of nitrogen by the spark discharge. Hydrogen only dilutes the nitrogen and does not take part in the action ($N + N = N_2$). Nitric oxide combines with active nitrogen, giving a greenish-yellow flame, due to the nitrogen peroxide produced, in all probability. Fourteen parts by weight of "active" nitrogen give seventy-six parts of nitrogen trioxide and consequently the amount of active nitrogen is about 2·5 per cent. of the total nitrogen present. The active nitrogen has the property of developing the metallic spectra when certain volatile metals are heated in it; ozone is known to do this also in some cases, but all attempts to isolate active nitrogen by condensation in liquid air have not succeeded. The spectrum is simpler than the ordinary nitrogen spectrum; and considerations such as these point to the probability of active nitrogen, being nitrogen in the atomic condition.

The writer has noticed that the flame of ammonia burning in oxygen has several peculiarities, which lead to the idea that the first action—the action going on in the inner cone giving a yellow luminosity—is merely the splitting up of the ammonia into hydrogen and nitrogen atoms, which then combine as in the case of active "nitrogen." The flame has a colour and spectrum similar to that of the active nitrogen glow; the shape of the inner cone is always such that it exhibits a rounded appearance indicating that it is a decomposition rather than a combustion with upward rising gases which produces pointed flames. There is a considerable amount of nitrogen peroxide produced, but this would probably be due to the combustion of the molecular nitrogen and oxygen; but the main products of combustion are nitrogen and water. A small yellow streak of the same colour is noticeable in the flame of burning cyanogen between the pink and violet cones, and may be due again to some re-combining atoms of nitrogen. In these cases it is necessary to distinguish the yellow flame due to the production of oxides of nitrogen and the glow due to recomposition of nitrogen atoms.

SPECTRA.—Much work has been done recently on the shift of the lines in the spectra of metals by the effect of pressure. Pressure would at first sight only appear to change the molecular conditions of a substance, and could hardly [illegible] within [illegible] the atoms. However, [illegible] Ri[illegible] and [illegible] pointed out, it is a [illegible] and it would seem [illegible] emitted from atoms [illegible] pressure [illegible] in these properties [illegible] which depend on the [illegible] inductive capacity. [illegible] has recently examined the luminous efficiency of various gases contained in vacuum tubes, through which an electric current is passed. The luminous efficiency of air, carbon dioxide, helium, and [illegible] is of the order fifteen to twenty per cent., owing to a large proportion of the energy being distributed as infra-red radiation. The infra-red radiation in neon is almost entirely absent, and the luminous efficiency is upwards of ninety per cent.

Professor Jones has given an account of some work on absorption spectra and the solvate theory of solution in the May number of *The Philosophical Magazine*. A salt dissolved in a given solvent is characterized by a definite absorption spectrum; when such is dissolved in varying mixtures of two solvents only two definite absorption spectra appear, one being characteristic of each solvent; only the relative intensities of these two spectra change on changing the relative proportions of the two solvents. Thus neodymium chloride dissolves in alcohol and in water, giving rise to methyl-alcohol bands and water bands, the intensity of which depends on the amount of methyl alcohol and water present; it appears that there is evidence in favour of the view that there are definite hydrates and alcoholates in solution. The solvate theory of solution which is being developed by Jones and his pupils supplements the theory of electrolytic dissociation, and is not at variance with it.

Havelock has found that the departures from Kundt's rule, that the greater the refractive power of the solvent the greater the shift of the absorption bands of a solute towards the red, are due to the formation of molecular aggregates. It is well known that Kundt's rule is only true for a few substances in dilute solution.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

SKIN OF HAIRLESS DOGS.—Darwin and others have directed attention to the occurrence of hairless dogs, especially in warm countries. They are often called by such names as "Egyptian" and "Chinese," and many of them show very abnormal development of the teeth. A study of the skin of such dogs has recently been made by F. G. Kohn, who finds in the new-born puppy (1) a variety of stages in hair development in a state of arrest, and (2) an abnormal development of horny material and an abnormal distribution of pigment. On the one hand, the skin is like that of a young embryo; on the other hand it is abnormal. The condition is not a gradual adaptive diminution of hair, such as may have occurred in the case of man. It is an abrupt hereditary "mutation" of unknown origin.

FEATHERS AND SCALES.—Aristotle discerned the deep-seated sameness of feathers and scales, and the view that they are homologous has been generally accepted. But it is not without its difficulties, for the development of the feather, though much nearer that of a scale than that of a hair, is very distinctive. And there are no transitional types between scale and feather. The minute flat feathers on a penguin's wings are no nearer scales than are the plumes of an ostrich. Some light has been recently thrown on the question by Frieda Bornstein's careful study of the foot of the capercaillie where feathers and scales occur in such close association. The conclusion reached is this, that a feather corresponds not to an entire scale, but to part of a scale, another part being suppressed. The same view has been previously maintained by Gluge.

ALLEGED RUDIMENTS OF TEETH IN MODERN BIRDS.—The fact that teeth occurred in the oldest known fossil bird (*Archaeopteryx*), and in many of its extinct successors as well, has led to a repeated search for hints of teeth in the embryos of modern birds. From time to time since Geoffroy St. Hilaire, it has been announced that in embryos of parrots and terns, and some other birds, traces of tooth-germs occur on the jaws. Dr. Ihde has recently re-investigated some of the alleged cases and with quite negative results. Distinct papillae sometimes occur, but they are in no sense tooth-germs. They show no trace of dentine, and they do not develop as teeth do. The "dental ridges" described by Rose have to do with the development of the horny bill; they are not comparable to the true dental ridges of mammals.

MEMORY IN FISHES. Michel W. Oxner has experimented with the sea-perch, *Serranus scriba*, in the following fashion. He hung in an aquarium a red and a green cylinder by silk threads of similar colour, and put food in the red one only. For the first two days the fish did not approach the cylinders; on the third day, after fifteen minutes, it entered the cylinder and ate the food; on the fourth day it did this after five minutes; on the fifth day after half a minute; from the sixth to the tenth day it rushed in at once. On the eleventh day it entered a fresh red cylinder which had no food, and waited there for three minutes. An association had been established between the colour and the food. The fish rushed into the empty red cylinder on each of the succeeding six days, and when M. Oxner dropped in some food a little was taken. On the eighteenth, nineteenth, and twentieth days, the fish would not eat the food. Even in the absence of appetite, the fish seemed unable to resist rushing into the red cylinder. In other experiments the colours were altered, but the same general results were obtained. There is no particular attraction in the red colour. What is established is first an association, and eventually something almost like a reflex.

BODY POISON OF SPIDERS. It has been known for some time that extracts of much-liked spiders contain a poison —arachnolysin—which has a destructive action on blood corpuscles. Robert Levy has recently shown that the body-poison is confined to adult females, is particularly localised in the ovaries, and is got rid of in the eggs. It is readily obtained from the eggs of the garden spider, for instance. From the eggs the arachnolysin passes on into the young spiders, but thereafter disappears altogether in the males, and until maturity disappears in the females. This body-poison and egg-poison is not to be confused with the poison which all spiders have in their poison glands. Levy's facts doubtless form a contribution to the physiology of sex, but it is difficult to discern their significance. There are analogous facts in regard to some other animals. Thus Phisalix found that in female toads the toxins normally secreted by the cutaneous glands are localised in the ovary and pass into the spawn. They disappear, however, in the tadpoles.

SENSITIVENESS OF BLOW-FLY. It is well known that the blow-fly (*Calliphora vomitoria*) has an extraordinarily keen sensitiveness to the odour of flesh, detecting it from a distance. Xavier Raspail has made some observations on the rapidity with which the flies find a bird that has just died and he maintains that they do not alight a second before that. An apoplectic pigeon that looked dead, but was not, was left unvisited. A moribund magpie, lying beside two others which had just been killed, was left unvisited though the flies were on the dead birds just beside it. The instinct not to lay eggs in anything not quite dead seems to be strongly developed. But Raspail goes on to draw the hazardous conclusion that in the article of death an animal gives off a volatile something of infinite subtlety which serves as a clue to the fly.

REVIEWS.

ASTROLOGY.

Chaldean Astrology.—Second edition. By G. Wilde. 150 pages. Numerous illustrations. 8½-in. × 6¼-in.

(T. W. Laurie. Price 6/- net.)

This is one of a series of books on Psychical Research with which we have no sympathy. For the elevation and preservation of the mental character and respect of mankind we would rather this useless subject of horoscopes and its allies were as dead as the ancient Aramaic race which inhabited the mountain regions near Ararat. We would also have preferred to have let the printing and dissemination of astrological works, except as an exercise in exposing the mythological origin and its close associations with witchcraft, sorcery, and similar abominations, cease with those ingenious concoctions published in the sixteenth century, with which we are acquainted. In the regeneration of the Chinese nation it is most earnestly desired that one of their greatest errors—their continued addiction to astrological notions—may be swept away for ever, and that a wholesome knowledge of the heavenly bodies may occupy their attention instead of the practice of this "occult science." The writer of the preface says "it is not intended to denounce or discourage the pursuit of occult studies"—of course not, or away would go the profits derived from such books as this—"but simply to insist that they have nothing to do with astrology, which is a physical and verifiable science or it is nothing." It is nothing but a delusion.

The preface also says: "The author possesses as much experience, as much ability, and what is equally important, as much candour and love of truth as will easily be found in any contemporary astrologer." We have no doubt whatever upon this point. We would like to emphasize this and add "or from the time of the tablets of Sargon I of Agadi, B.C. 3800." No, this would not be quite true. The poor ancient folks only had the sun, moon, and five major planets with which to work out their schemes. It is quite alarming to meditate upon the enormous amount of misconception, misinterpretation, inefficiency, and disturbance upon human lives in the horoscopic prognostications of the period previous to the discovery of Uranus in 1781 by the non-horoscopic Herschel, and by the discovery of Neptune in 1846. It will be interesting to watch the re-arrangement of the "houses" when a new lord of the ascendant, "significator," is discovered as the ninth major planet, also how it will act as a "promittor." We offer a suggestion. As the seventh major planet was discovered with a telescope, the eighth by mathematical calculation, will the horoscopists discover the ninth by deduction from the falsities, anomalies, and inexplicabilities in their present forecasts, and indicate to astronomers where we may see that planet? We might "horoscope" its name as "Horoscopia."

When we first perused this book we thought of conjuring our horoscopes according to the accommodating data given—passing thoughts make us think of some of the well-known patent medicines which cure or soothe opposite ailments—but we have come to a definite decision, that as we believe we are greatly controlled and *our* lives influenced by the *ninth* planet we must reluctantly wait until its discovery (by horoscopy, preferably). When one has an hour or more to waste it is an interesting book to read, as one can readily find something to satisfy for the moment, and dissatisfy for longer periods. It is astonishing that any but heathens and atheists can believe such stuff. So long as there are people with time and money, so long will such books be inflicted upon us. A short time ago a "prophet" named Voigt, wrote and published a work predicting the end of the world. He was justly prosecuted and heavily punished by the Berlin police for "spreading pernicious literature." Would that we had such a law enforced.

F. A. B.

EVOLUTION.

Evolution in the Past.—By Henry R. Knipe, F.L.S. 242 pages. 56 full-page illustrations. 10¼-in. × 7¼-in.

(Herbert & Daniel. Price 12/6 net.)

An immense amount of care and trouble has been expended in order to ensure that this book shall be at once attractive and reliable. The introduction gives a very clear and con-

[illegible] account of the theory of Natural Selection, while the first chapter shows how multicellular forms arose from unicellular organisms. The bulk of the work describes the [illegible] of life which were to be met with during the recognized geological epochs, and we are told how creatures appeared, developed, [illegible] or persisted, in some cases, to the present day, [illegible] left modified descendants whose [illegible] we can occasionally trace in detail. We are certainly [illegible], and that is why, perhaps, we should like to have had a little more theory as to how one group evolved in the [illegible] from another, how, for instance, birds were derived from reptiles. Imagination, tempered by the advice of experts, has had to have some play in the many full-page [illegible] by Miss Alice Woodward and Mr. Bucknall, which illustrate the volume. There is an absence of detail in some of these which is, perhaps, to be commended, for if features are not supplied, they cannot well be criticised. This remark one would say however, would not apply to the digits of *Archaeopteryx*.

We note that when discussing *Pithecanthropus*, which some consider to be hardly human, Mr. Knipe, not to be behind the times, calls it a super-ape. A feature of the book is the printing of the names of the various creatures discussed in the wide margins, and this adds to its general interest and usefulness. "Evolution in the Past" should be read and studied by all lovers of Natural History.

W. M. W.

MEDICINE.

Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. Vol. A. Medical. By Andrew Balfour, M.D., Director. 404 pages. 101 figures. 22 plates. 10¾-in. × 8-in.

(Baillière, Tindall & Cox. Price 21/- net.)

It is now three years since the Wellcome Tropical Research Laboratories issued their last report. The present volume deals with medical subjects only, while a second part is given up to general science. The laboratories are situated at Khartoum, and besides a well-equipped main building possess also two specially fitted steamers which are able to move wherever needed on the Nile. In his Annual Report for 1909 the Director-General of the Sudan Medical Department points out "what a valuable asset such a well-equipped laboratory, with well-trained observers, is in Khartoum," and the work done in the laboratories fully justifies this appreciation, for it is of the best, and the only wonder is how so much has been carried out in a tropical climate with so few assistants.

A large part of the report is given up to observations on the pathology of sleeping sickness, Kala-azar, "oriental sore," and other tropical diseases. But subjects of more general interest, such as diphtheria in the tropics, tropical sanitation and the water supply of towns in the tropics are also dealt with. In glancing through the report one is especially struck with the excellence of the microscopic observations described in it, and for readers outside the tropics the chapter on "Fallacies and Puzzles in Blood Examination" is, perhaps, of the greatest interest.

The report is well written—every page of it is readable and full of interest—and the illustrations are delightful. There are numerous diagrams and reproductions from photographs, and the twenty-two plates illustrating various blood parasites are for the most part beautifully reproduced in colour; there is also an excellent index. The report is absolutely indispensable to research workers in tropical countries.

S. H.

Second Review of some of the Recent Advances in Tropical Medicine, being a Supplement to the Fourth Report of the Wellcome Tropical Research Laboratories at the Gordon Memorial College, Khartoum. By Andrew Balfour, M.D., and Capt. R. G. Archibald. 418 pages. 10¾-in. × 8-in.

(Baillière, Tindall & Cox. Price 15/- net.)

This is the second time Dr. Andrew Balfour and his colleagues have gone to the trouble of collecting together for [illegible] the results of recent work in Tropical Medicine and allied sciences, the first review appearing as a supplement to the Third Volume of their Reports in 1908. Fortunately, as is pointed out in the preface, it is most improbable that anything of this kind will be required again, for *The Medical Officer* now issues a monthly review supplement giving an excellent résumé of the current literature on bacteriology and protozoology.

The subjects in the Review are arranged alphabetically and at the base of each page full references of the matters referred to in the text are given. Besides this, there is a very complete index at the end of the book.

The value of a book such as the above depends almost entirely upon the completeness with which references to the subjects dealt with have been sought for and the care with which abstracts have been made from them. On the whole we are inclined to think the work has been very well done, but we should like to have seen at least some reference to the really valuable observations made by Beauchamp Williams on the bacteriology of leprosy. The only faults we have been able to discover, however, are faults of omission and these we think are not very numerous. We are sure that every worker in Tropical Medicine will feel that they owe to the staff of the Wellcome Tropical Research Laboratories a very great debt of gratitude.

S. H.

MICROSCOPY.

Microscopy and the Microscopical Examination of Drugs. By Charles E. Gabel, B.S., Ph.D. 122 pages. 71 illustrations. 8¼-in. × 5½-in.

(Charles E. Gabel, Iowa, U.S.A. Price $1.)

The number of books available for the student in any branch of microscopy is now considerable, but it is doubtful if any one of them attempts to cover so much ground in so little space as that now noticed. The result is, as might be expected, that the matter provided is, in nearly every instance, incomplete and unsatisfying. Barely four pages are together devoted to a description of lenses, microscopes, ultramicroscopes and photo-micrography, with the result that the student is left with the vaguest possible idea of the subject, much less of the principles governing the use of such appliances. The expressed intention is to provide a book that to some extent replaces the student's lecture note-book, and it may be that in this sense it will appeal to some readers; but it must be confessed that in other respects it will fail to be of service even to elementary students, as the matter provided is not put forward with sufficient scientific accuracy to form a good groundwork.

J. E. B.

Micropetrology for Beginners.—By J. E. Whinfield Rhodes, B.Sc. 126 pages. 26 illustrations. 7½-in. × 5-in.

(Longmans, Green & Co. Price 2/6 net.)

The microscope is now becoming a universal tool in all branches of science, but perhaps in no direction has it achieved such satisfactory results as in Petrology and Metallurgy. No branch of work demands that the instrument should be more thoroughly understood, to enable the best work to be done, than Petrology, as its study involves the use of special appliances and methods. The book here considered provides the beginner with just the information required, the instructions on the use of the petrological microscope and the method of handling and using its various parts being concise and sufficiently explanatory. It will undoubtedly bridge over the gap that exists between general text books on Geology and the specialised books on Petrology. The description of a selected series of igneous rocks follows and to the amateur, at least, it will be of interest to know, sets of slides to illustrate the work described can be obtained commercially. In every sense, the object in view appears to have been attained and the book may be commended as a guide to those commencing this interesting branch of microscopy.

J. E. B.

ZOOLOGY

Earth and her Children.—By HILDA(?) M. LIVENS. Illustrated by Horace Mann Livens, Fanny M. Minns, Geoffrey Livens, and others. 248 pages. 92 illustrations. $7\frac{1}{2}$-in. × 5-in.

(T. Fisher Unwin. Price, 5/- net.)

This is a nature-book for young children, conversational in its method, fanciful in its nomenclature, altogether pleasant and wholesome in its outlook. The text is both adorned and illustrated with interesting drawings. We have noticed that when birds and beasts and trees and flowers are made to answer questions in a book, some children are bored, while others not more imaginative are much interested. Those of the second mood will enjoy "Earth and her Children."

J. A. T.

The Ox and its Kindred.—By R. LYDEKKER. 271 pages. 55 illustrations. $7\frac{1}{4}$-in. × 5-in.

(Methuen & Co. Price 6/-.)

Mr. Lydekker will earn by this volume the gratitude of naturalists and [illegible] folk. For there has been a [illegible] [illegible] [illegible] comprehensive and not too technical account of the origins of domesticated cattle and their decipherable history. The author deals mainly with the extinct wild ox and the domesticated breeds, but three chapters are devoted to existing wild cattle, to hybrid cattle, and some extinct cattle other than the aurochs. He displays throughout his wonted competence and clearness. There are many difficult questions discussed, but Mr. Lydekker treats them without dogmatism in a judicial scientific temper. Thus, in regard to the much debated question of the British Park cattle, he lets the various views have their innings in turn. In his own opinion, "the half wild cattle which are known to have roamed through the British forests in the time of Fitz Stephen, but whose precise origin and relationships cannot now be determined, may perfectly well have given rise to the various park-breeds, without the intervention of imported breeds." All park cattle and the older British breeds are derivable, with or without the intervention of the Celtic shorthorn, from the exterminated aurochs (*Bos taurus primigenius*).

J. A. T.

BRIEF NOTICES OF BOOKS.

The list includes books which have been received since the last number of "KNOWLEDGE" went to press.

The Espérance Morris Book. Part II.—Edited by MARY NEAL. 48 pages. 12 illustrations. $12\frac{1}{4}$-in. × $9\frac{1}{2}$-in.

(J. Curwen & Sons. Price 5/-.)

The efforts of Miss Mary Neal to revive Morris and country dances in England are well known. This book, edited by her, is the second part of one which has already appeared. It contains some reproductions of very interesting photographs with notes on tunes and dances which have been written by Mr. Clive Carey, who, with Mr. Geoffrey Toye, has collected the music which is printed in the volume.

Studies in Seeds and Fruits.—By H. B. GUPPY, M.B. 528 pages. 9-in. × 6-in.

(Williams and Norgate. Price 15/- net.)

Fruits always form a pleasing subject, though seeds are perhaps neglected by the nature student. Those who are attracted by either will find much of interest in this solid contribution to botany.

Peeps at Industries—Rubber.—By EDITH A. BROWNE. $7\frac{3}{4}$-in. × $5\frac{1}{2}$-in. 88 pages. 24 illustrations.

(A. & C. Black. Price 1/6 net.)

We hear so much about Rubber at the present day that a short illustrated account of its history and cultivation is most welcome and Miss Browne has dealt very interestingly and exhaustively with the many aspects of the subject, in the space at her disposal.

A Manual of Practical Bio-Chemistry.—By H. LEIGHTON KESTEVEN, D.Sc. 64 pages. 7-in. × 5-in.

(The Australian Book Co. Price 2/6 net.)

One hundred and one experiments are dealt with in the work. The laboratory directions form the bulk of the letterpress, which is printed on one side of the paper only so that it is possible for a student to cut them out and stick them into a note book.

A Class Book of Physical Geography.—By A. T. SIMMONS, B.A., and ERNEST STENHOUSE, B.Sc. 436 pages. 222 illustrations. $7\frac{1}{2}$-in. × 5-in.

(Macmillan & Co. Price 4/6.)

Although assistance in the framing of this book has been derived from a study of the syllabuses of all the principal examining bodies, and the descriptive portions of the volume will be found complete as a text book, yet practical exercises are set out at the beginning of the various sections, and much of its educational value will be lost by students who neglect these for they will not become observers able to reason intelligently on the facts encountered.

The Lantern and How to Use it.—By C. GOODWIN NORTON and JUDSON BONNER. 146 pages. 93 illustrations. 7-in. × 5-in.

(Hazell, Watson & Viney. Price 1/- net.)

The Lantern is so indispensable now and so many methods of obtaining a light are used, that it is necessary for anyone who wishes to project illustrations on to the screen to know something about the subject before making a choice of apparatus. The information required can be got from the book under consideration which has been brought up to date, and includes also many useful hints by which the would-be lanternist cannot but be helped considerably.

Tables Annuelles Internationales de Constantes et Données Numériques, Vol. I. 727 pages. 11-in. × $8\frac{3}{4}$-in.

(J. & A. Churchill. Price 21/6 paper, and 24/- bound in cloth).

We have received this important work and it is interesting to chronicle that it contains a series of postcards which can be torn out so that any reader may point out mistakes or omissions that he may possibly discover.

A School Algebra.—By H. S. HALL, M.A. 550 pages. $7\frac{1}{2}$-in. × 5-in.

(Macmillan & Co. Price 2/6.)

The present instalment forms Parts 2 and 3 of the book. As in Part 1 very special care has been taken with the pagination. The matter is so arranged that it is never necessary to turn over in the middle of any particular paragraph, and so the reader is not once disturbed. This feature is probably unique, and not to be found in any other mathematical text book.

How to use the Microscope.—By CHARLES A. HALL. 88 pages. 20 plates. $7\frac{1}{2}$-in. × $5\frac{1}{4}$-in.

(Adam and Charles Black. Price 1/6 net.)

The microscope is a tool which everyone should be able to use, whether for business or for pleasure, and any book which helps the beginner makes for good. At the same time it must be pointed out that it is more useful to introduce new observations than to repeat old ones, and hence we should have preferred that the illustrations, though they are excellent, should have been of a less hackneyed character. The proboscis of the blow-fly, the mounted flea, and the eye of a beetle have become too well known. Though proverbs are often wrong, in this case familiarity does tend to breed contempt.

Aristotle's Researches in Natural Science. By THOMAS EAST JONES, M.A., LL.D. 274 pages. 10 illustrations. 8¾ in. × 5¾ in.

(West, Newman & Co. Price 6/- net.)

The fact that some of Aristotle's views are held at the present day gives a particular interest to his work, and Dr. Jones deals with it in detail.

Bush Days. By AMY E. MACK. 132 pages. 20 illustrations. 7½ in. × 6 in.

(The Australian Book Co. Price 3/6 net.)

This little book consists of a number of short articles dealing with the plants and animals of the bush which in the neighbourhood of Sydney is rapidly giving way before bricks and mortar, trams and trains. The pictures and the descriptions deal, therefore, with matters on the other side of the world, and cannot fail to attract and interest nature lovers in the old country.

Dictionary of Photography. By E. J. WALL, F.R.P.S. 738 pages. 7½-in. × 5-in.

(Hazell, Watson & Viney. Price 7/6 net.)

A hundred new pages have been added to this the ninth edition of a most useful work, which is full of information, suggestions and valuable hints.

The Oil and Bromoil Processes. By F. J. MORTIMER and S. L. COULTHURST. 99 pages. 8 illustrations. 7-in. × 5-in.

(Hazell, Watson & Viney. Price 1/- net.)

The success which has attended Messrs. Mortimer and Coulthurst's handbook is evidenced by the production of this second and revised edition.

The Doctor and the People. By H. DE CARLE WOODCOCK. 312 pages. 7¼ in. × 5 in.

(Methuen & Co. Price 6/- net.)

The appearance of this book is most appropriate. It brings before one the everyday life of the doctor, and many points which the ordinary member of the community will do well to study, while it is claimed that it exposes faults of raw legislation which is the work of men who, though mature politicians, are nevertheless ignorant of sociology.

Zoology. By GRAHAM KERR, F.R.S., F.Z.S. 99 pages. 13 illustrations. 6¾ in. × 4½-in.

(J. M. Dent & Sons. Price 1/- net.)

A small primer when it gets into the hands of a young person who is interested, very often produces results of which the writer may well be proud. This little book seems intended, however, rather to give a very brief outline of the animal kingdom and the method of evolution for the adult enquirer.

For and Against Experiments on Animals. By STEPHEN PAGET. With an introduction by Lord Cromer. 344 pages, 16 illustrations. 7½-in. × 5-in.

(H. K. Lewis. Price 3/6 net.)

We are glad to see that the word vivisection does not appear in the title of this book, and though there are some who, when they have once become biased against a matter, are not easily persuaded to look upon both sides of it, we would urge all those who pride themselves on being anti-vivisectionists to read Mr. Paget's book and Lord Cromer's introduction to it.

NOTICES.

A REGULATOR FOR X-RAY TUBES. — In *The Archives of the Roentgen Ray* for May, 1912, Dr. Gustav Losse describes the air regulator for X-Ray bulbs which has been perfected by Bauer. By its means a measured quantity of air may be allowed to enter the bulb. The advantages of the invention are illustrated by Dr. Losse from his every-day practice. Occasionally in damp or stormy weather he gets a certain amount of reverse current from his coil which is very deleterious to the life of the tube. The cure is a valve tube which soon, however, becomes so hard that it has to be regulated. To obviate the continuous annoyance of softening this, Dr. Losse has preferred to put up with a reverse current. The attachment, however, of a Bauer regulator has given him a perfectly useful and practical instrument. The secret of the production of a fine skiagram lies entirely in the choice of rays of the appropriate degree of hardness. By adjusting the hardness by means of Bauer's regulator we can obtain plate after plate perfectly similar in appearance and exposure. It is no longer a fault for an X-ray bulb to become rapidly hard because this difficulty can now be easily overcome while the reverse cannot. In the future, perhaps, the manufacturer will advertise his X-Ray tubes as the best on the market, because they become rapidly hard.

BOOKS ON VOYAGES AND TRAVELS. — Messrs. J. Wheldon & Company's catalogue issued under this title includes a number of books on Australia and New Zealand, and indeed many other countries abroad.

THE VEGETATIVE CHILD.—English doctors have pointed out before now that the puny boy is the outcome of too little clothing. Dr. Mary Sutton (of New York University) contributes to *The Child* for May "a Biologic Study of Early Child Life," and touches on the fact that during the vegetative period of life the child has a relatively large radiating surface to the body, and despite the more rapid formation of much more heat in the child than in the older individual, the vegetative infant has little power of resistance and therein lies the danger of improper or inadequate clothing.

THE REMOVAL OF TESTS FROM FOSSILS.—In *The Naturalist* for May, Mr. Buckman gives the following directions for removing the tests from fossils (especially of brachiopods of which natural casts are rarely met with). Choose specimens which are not crystalline, and preferably those which are likely to have a close grained hard internal core. Heat them to redness (in a fire or preferably by means of a Bunsen flame, spirit or blow-lamp) and drop them into water. Much of the test will then fall off and the rest can be detached by brushing or the delicate use of a pen-knife.

ASSORTATIVE MATING IN MAN. — The statistical facts brought forward by Dr. J. Arthur Harris in the May number of *The Popular Science Monthly* make it highly probable that a great variety of physical and mental characters influence human mating, and show that, on the average, similar individuals tend to marry. Dr. Harris thinks that his results will be received with much scepticism as the "charm of the disparity" and "the selection of opposites" has been so long asserted that the notion will not readily be given up. He thinks that this scepticism may be ignored, but reminds his readers that popular beliefs often contain a scrap of truth.

BIBLIOTHECA CHEMICO-MATHEMATICA. — The latest number of Messrs. Henry Sotheran & Company's scientific catalogue contains the titles of upwards of two thousand books dealing with Mathematics, Astronomy, and kindred subjects, arranged under the authors' names from the letter "E" to "L." Those of our many readers who are interested in these subjects should make a point of getting a copy.

A HANDBOOK OF MARINE AQUARIA.—The notes which have been issued on the Aquaria in the Horniman Museum, Forest Hill, have been entirely re-written. The creatures dealt with are those which are generally to be found in the Aquaria there. Rare forms are not included, as in their case special labels are attached to the tanks when they happen to be on view. This little handbook cannot fail to be of great use to all students using the museum, and it costs but a penny.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News

A Monthly Record of Science

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JULY, 1912.

THE KALEIDOGRAPH.

By E. WILFRED TAYLOR.

THE Kaleidograph is, as its name implies, a machine by means of which very beautiful and complex designs may be drawn by the simple process of turning a handle.

In the space at our disposal it is quite impossible to give more than the briefest description of the design and construction of the machine, or of the many adjustments and alterations which may readily be made and by means of which the character and complexity of the designs are rendered almost limitless.

Briefly, the machine consists of three parts, each of which supplies some form of motion. These motions, when brought together by means of a pantograph, produce the designs with which this article is illustrated.

To the right of Figure 271 is seen an elliptic table (A). On the upper surface of this there are guides in which two runners slide along diameters at right angles to one another; the turned tops of these runners fit into the horizontal radial arm (B) above the table. Along the top of this arm another runner slides and may be clamped in any position; this carries the tracing point (C) of the pantograph.

The radial arm is rotated by an arm (D) fixed to a pulley beneath the elliptic table; the driving cord passes round this pulley. As this arm carries the radial arm round it will be seen that the tracing point describes an ellipse, the form of which is governed by the positions of the two runners in the ellipse table, and by the position at which the tracing point is clamped to the radial arm. By varying this position the ellipse may be thinned out into a straight line or by removing one of the runners and clamping the other in its guides, a circular movement of the tracing point is easily obtained.

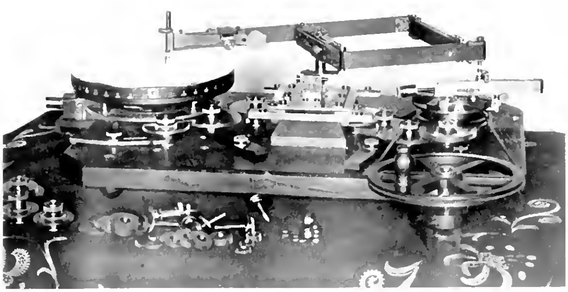


FIGURE 271. The Kaleidograph.

The motions of the tracing point are transmitted unchanged to the pen over the drawing table, and as the radial arm revolves, an ellipse is drawn around which the pen will work as long as the arm is rotated.

By means of gearing, the elliptic table itself can be made to rotate in a direction the same or opposite to that of the radial arm. Thus the ellipse is made to rotate, and the number drawn in a complete rotation of the table depends on the gearing inserted between the two equal spur wheels beneath the table (A). The upper of these carries round with it the radial arm which in turn carries round the tracing point; the lower rotates the elliptic table.

In the centre of the machine are two sliding tables: the lower (E) slides towards and away from [illegible] often required, and [illegible] throwing the upper table out of [illegible] eccentrically and [illegible] only the lower table. Figure 275 was drawn with a circular motion at the central pivot

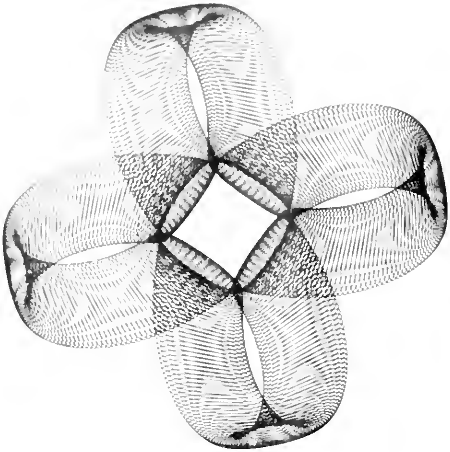


FIGURE 273.

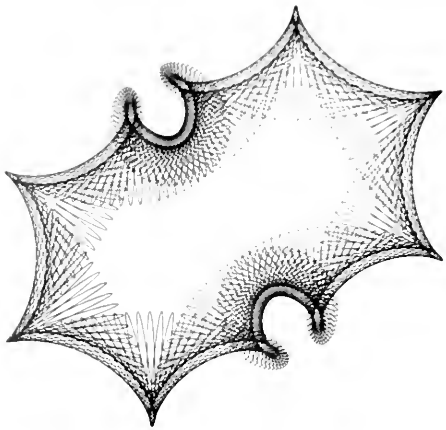


FIGURE 274.

motions of the tables are not required: the upper has a runner sliding in guides across its diameter. This may be clamped in any position and regulates the motion of the sliding tables—the more eccentric its position the more motion it imparts to the tables above. It is not always desirable to have both

while for Figure 276 only the lower table was used. The central pivot of the pantograph is fixed above the tables and is carried along by them, all motion at this point being doubled at the drawing end of the pantograph.

The gearing inserted between the elliptic table

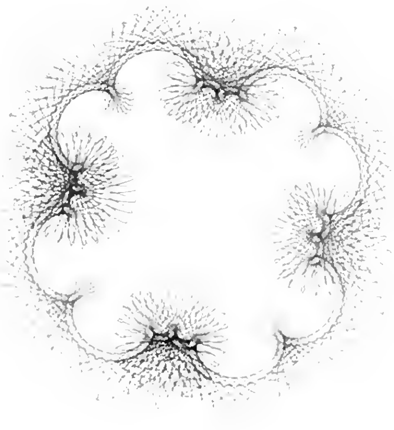


FIGURE 276.

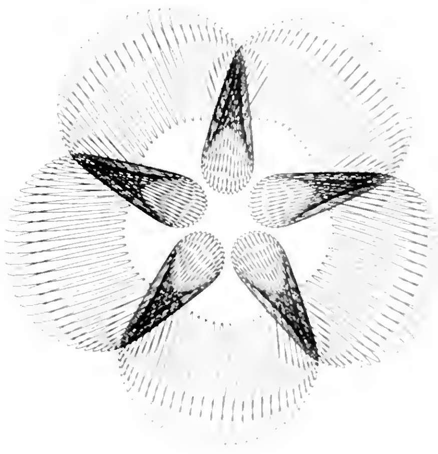


FIGURE 275.

sliding tables in use, as together they impart a circular motion to the central pivot (G) of the pantograph, whereas a simple harmonic motion is

and the central sliding tables has a great influence over the resulting design.

To the left of the machine is the drawing table (G), which is mounted over a large spur wheel. Beneath this again is a smaller wheel which can, by means of an eccentric, cause the upper portion of the drawing table to move across the lower in a straight line

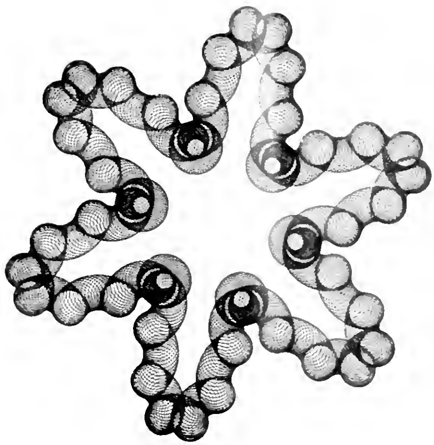


Figure 276.

backwards and forwards. The distance it travels is easily controlled by the eccentric, while the upper spur wheel is clamped when this motion is required.

Usually the drawing table revolves centrally, but by clamping the lower spur wheel and throwing the upper part of the drawing table eccentric an

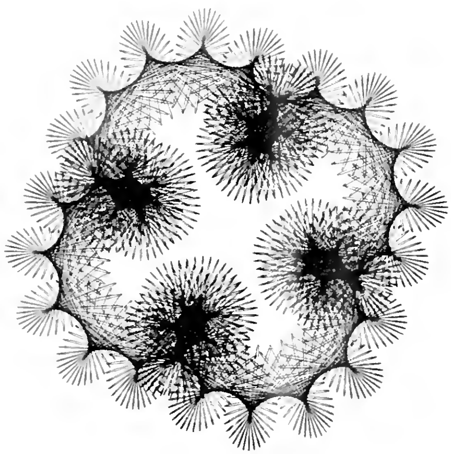


Figure 277.

elliptical motion is obtained. (See Figure 274.)

The gearing between the central tables and the drawing table plays an important part in the form of the resulting design, as also does the direction in which the drawing table rotates. Figures 278 and 279 require almost the same setting, except that the drawing table revolves in opposite directions.

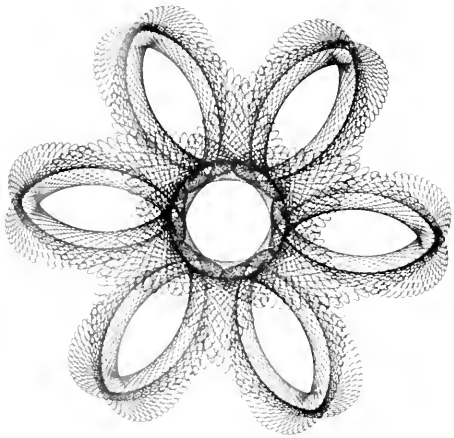


Figure 278.

This, of course, is not responsible for there being six arms in the former and only three in the latter.

When we consider the number of simple and complex motions which can be brought into action together or independently in varying ratios and opposite directions, it is not surprising that the

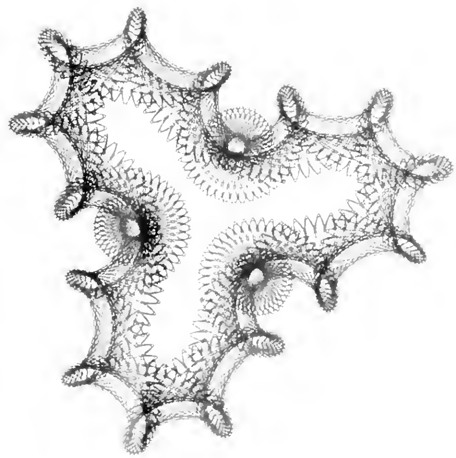


Figure 279.

resulting designs should be almost limitless in variety.

In order to make a little clearer what part each of these movements jointly on the design, it will be well to analyse the movements which have resulted in Figure 276.

In this case the tracing point (T) of the pantograph described a circle. This motion was obtained by removing one of the runners and clamping the remaining one round which the radial arm (B) rotated, carrying with it the tracing point. The position of the tracing point along the arm governed the diameter of the circle.

Between the upper and lower spur wheels beneath the elliptic table gears were introduced so that twenty-four circles were drawn to each complete rotation of the ellipse table. Gears were also introduced between this and the central sliding table so that the elliptic table revolved eight times while the central sliding table (E) moved once forward and backward. This, together with the fact that the runner was clamped a little eccentric on the elliptic table, is responsible for the eight nodes in each of the six arms, while there are twenty-four complete circles between any node and the next.

Only the lower of the two central sliding tables was used, and the distance it traversed was responsible for the length of the arms in the design.

The drawing table revolved centrally, one complete revolution coinciding with six double movements of the central sliding table. Thus the design has six arms.

[illegible] lancewood, [illegible]. A piece of glass [illegible] drawn to a point and ground down until when the point is immersed in water and the other end blown down, a few bubbles are seen to slowly escape. The pen is filled with a solution of aniline dye.

The diagrams illustrating this article have, of necessity, to be coarse and give little idea of the delicacy that can be attained.

Very beautiful effects are produced by drawing such a design as Figure 275 in blue, turning the drawing table through 30° and repeating the same design in crimson. The form of the ellipse may also be slightly altered and the new design superimposed on the previous one, as was done in Figure 279.

An original and very convenient method for holding the gear wheels in position is used on this machine, and an examination of Figure 271 will perhaps make the method clear. The required wheels are slipped on to a drum and clamped together by a milled nut. The drum and wheels are then slipped together on to a spindle round which they can freely revolve. The spindle is clamped to the baseboard of the machine by means of another milled head, which springs a forked piece of lancewood, causing it to press the base of the spindle firmly down to the woodwork of the machine. They can thus be clamped in any position.

SOLAR DISTURBANCES DURING MAY, 1912.

By FRANK C. DENNETT.

During May the Sun's disc appeared free from disturbance on thirteen days, 7th, 12th, 15th to 24th, and 30th, and on six others, 5th, 9th to 11th, 25th and 26th, only faculae were visible. The central meridian at noon on May 1st was 2° 1'.

The great faculic disturbance which originally appeared around the spot disturbance No. 1 in longitude 295° has continued visible, extending forward in longitude, and now reaching to 330°, but scarcely extends so far back as its place of origin. It is to be noted that the groups of spots Nos. 1, 3, 4 and 6 have all appeared within this area. Only one other faculic disturbance was recorded during the month, a small one near longitude 68° and in somewhat high South latitude, but its exact position was not measured.

No. 4 is an outbreak belonging to the April list, but shown on the present chart as it continued visible until May 6th.

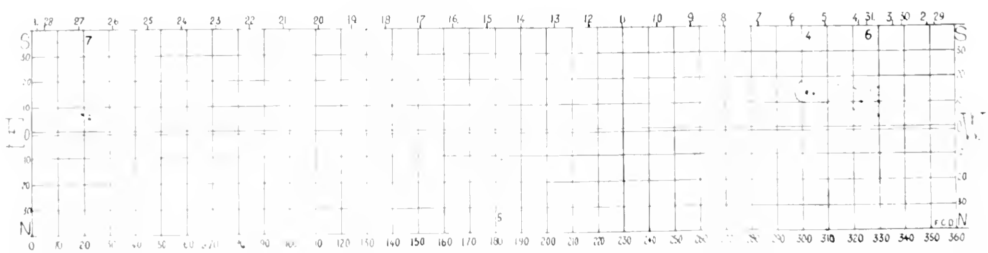
No. 5.—A black pore visible on the 13th and 14th only, appearing smaller on the later date. On the afternoon of the 13th it was followed by a smaller grayish pore.

No. 6.—A group of very small pores, constantly changing in appearance, at the western end of the great faculic disturbance. Although never at one time more than 52,000 miles in length it seems to have been in reality 89,000 miles in extent, and was seen from the 27th until the 29th.

No. 7.—A group of three spotlets and a pore seen on the 31st, increasing during the day, the eastern and western spots each having about three umbrae. The length of the group increased to over 60,000 miles, and the diameter of the lower, eastern, spot was 11,000 miles. It was only seen until June the 2nd, after which it passed round the limb. With the spectroscope it was finely seen, a considerable dark hydrogen flocculus just west of one of the spots branching off the C line on the red side, whilst the D_3 line of helium was dark and thick on the 31st.

The chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and the writer, made in places so far separated as Lisburn, Manchester, Bath and Hackney.

DAY OF MAY, 1912.



SOME RARE SUSSEX ORCHIDS.

By E. J. BEDFORD.

DURING the past season (1911), I was able to add several interesting species to the collection I am forming of British Wild Orchids, and perhaps the following particulars may prove of interest.

My intention is to secure photographs of every possible species *in situ*, as well as at closer quarters at home, when arranged against a plain background. I was exceedingly fortunate in obtaining two species which had not hitherto been recorded for East Sussex, and these will be described first.

During the month of May, a friend of mine, Mr. Herbert Jenner, of Lewes, found in the Ouse district, near Lewes, a specimen of the Brown-veined Orchis (*Orchis purpurea*), and by his kindness I was able to obtain a photograph of the plant *in situ* and of the blossom (see Figure 283).

Although the specimen was not quite so fine as typical ones occurring in the neighbouring county of Kent, yet as a record for East Sussex it was of considerable local interest.

It will be remembered that we experienced some late frosts during the Spring of 1911, and this specimen like many of the earlier species suffered in consequence, the leaves being frost-bitten at the tips, and even as late as June I noticed that many specimens of the Bee Orchis (*Ophrys apifera*) suffered in the same way.

This interesting find was the prelude of another of perhaps even greater interest, for in the month of June I was fortunate enough to come upon a specimen of the Lizard Orchis (*Orchis hircina*) in the Cuckmere district, near Eastbourne.

FIGURE 280.
The Spider Orchis (*Ophrys aranifera*) *in situ*.

FIGURE 281.
The Bog Orchis (*Malaxis paludosa*) in its natural habitat.

This also proved to be a record for East Sussex, although I believe a single specimen was discovered in West Sussex in 1907 near the extreme border of the county.

During the first week in June I had passed over the ground where the specimen was discovered and in the dusk of evening saw what appeared to be at a distance of several yards a plant of the Mullein (*Verbascum*).

It was, therefore, somewhat of a surprise to me in passing over the spot again about a week later (also in the twilight) to almost walk over a specimen of the Lizard Orchis which I had never dreamed I should be fortunate enough to find in Sussex. My thoughts at once went back to my previous visit to the locality, and I saw at once that this must have been what I had taken to be the Mullein.

My delight in the discovery may well be imagined by any botanist and I sat down beside the specimen debating in my mind whether I should pick it or leave it, as the flowers were not fully out—in fact, they had only just commenced to open. After considerable meditation I decided it must be picked as if it were left and someone else should discover it, which was more than likely owing to its position, the plant might be plucked up root and all before I had obtained a photograph and I should ever afterwards regret my loss. So I carefully cut off the blossom and packing it in my vasculum started homewards full of joy at my good fortune.

Several of my botanical friends were informed of my discovery, and they also saw the blossom, but I have not, and do not intend to divulge the exact locality, hoping that the plant may blossom again during the coming season.

The plant measured twelve-and-a-half inches in height and doubtless would have grown higher had it been left to do so.

It is interesting to notice in the photograph of the partly-opened flowers (see Figure 281) how the long lip is curled up in the form of a spiral under the hood and one may be seen partly uncurled.

The flowers opened at the rate of three or four each day, and about a week after the specimen had been picked all the flowers were open except those at the extreme tip. It was at this stage taken back and temporarily fixed to its own stalk and photographed *in situ* on 22nd June (see Figure 282).

FIGURE 282.
The Lizard Orchis (*Ophrys hircina*) *in situ*.

Earlier in the season I had found a very numerous colony of the Spider Orchis (*Ophrys aranifera*), which is one of the rarer species and very local in Sussex (see Figures 280 and 286).

Standing in one spot and revolving myself to face, in turn, the four points of the compass I counted the number of specimens I could clearly see in a circular space of about three yards radius from my standpoint and they numbered no less than sixty-five. They were in this profusion for a considerable distance on either side of me, and on making enquiries of my botanical friends I found only one of them had ever seen the species in such numbers.

Fortunately this species, like several of the others belonging to the Orchidaceae, does not flower every successive season, so that where one season the flowers are very numerous (as they were on this occasion) the next very few may be found.

It is as well that this is so, otherwise local species like this would probably be exterminated by continual plucking of the flowers and perhaps grubbing up of the roots.

The specimens which occur in Sussex are said to be *Ophrys aranifera* var. *fucifera*. I have experienced great difficulty, however, in distinguishing the variety from the type which is said to occur in Kent and sometimes in Sussex.

The species known as the Late Spider Orchis (*Ophrys arachnites*), which occurs in Kent, and, I believe, also in Surrey, is a very rare plant. I have heard that it has been found in Sussex, but have never seen it there myself.

As it occurs about a month later than *O. aranifera* there seems little doubt but that it is a distinct species, more related to *O. apifera* than *O. aranifera*.

Another interesting species to be found in Sussex is the Bog Orchis (*Malaxis paludosa*), which is very local and not at all common. This, as its name implies, is to be found in bogs and owing partly to its position, and also on account of its small size, is not at all easy to discover or, when discovered, to photograph.

It is said to be an epiphyte—that is, a plant which grows upon another plant, but which does not, like a parasite, obtain its nourishment from it. It is often, but not always, found upon Bog Moss (*Sphagnum*). The specimen shown in the illustration (see Figure (281) was growing upon *Sphagnum*, and was only one and a half inches in height, doubtless due to the very dry summer; which had the advantage, however, of making its habitat more easily accessible. Owing to the damp situation and the very small size of the specimen, it took a considerable amount of manoeuvring before the camera, which had to be placed almost upon the ground, could be brought into a favourable position to secure the photograph. Specimens seemed very scarce in Sussex during 1911, but this may have been due to the abnormally hot and dry season.

Darwin mentions in his book on "Fertilisation of Orchids"* that the specimens he experimented with were sent to him from Sussex, and it is interesting to note that there is very little doubt they came from the same locality as the one shown in the illustration.

This species is the smallest British Orchid, and its labellum or lip is, contrary to most others, directed upwards, this being brought about by the spiral twisting of the ovarium.

The proper direction for the lip of all Orchids is upwards, but the lower position is assumed by reason of the twisting of the ovarium. In *Malaxis* the twist continues until the lip is again brought round to the upward position.

This is well shown in the illustration of the species in Darwin's work already mentioned.

* Pages 129 and 130.

FIGURE 283. The Brown-Veined Orchis (*Orchis purpurea*)

FIGURE 284. The Lizard Orchis (*Orchis hircina*)

FIGURE 285. The Lizard Orchis (*Orchis hircina*)

FIGURE 286. The Spider Orchis (*Ophrys aranifera*)

THE TRANSMUTATION OF THE ELEMENTS.

By H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S.

I. The Theories of the Alchemists.

The alchemists have, in the past, been too harshly judged. Their views were certainly fantastic in form, their method of gaining truth unreliable; but they were not fools who hid their folly under an unintelligible phraseology, nor were they mere seekers after material wealth. We are, of course, referring to the genuine alchemists, not to the horde of swindlers, who in Alchemy's later days adopted the alchemistic guise for sinister purposes. The alchemists were philosophers who held a certain view as to the nature of the Cosmos, which they attempted to demonstrate by experiments on metals and allied substances.* The final proof of their theory, they believed, would be found in the transmutation of the "base" metals into gold; and it was as the final proof of their theory that they so ardently toiled to achieve this transmutation. As one of them exclaims, "Would to God . . . all men might become adepts in our art — for then gold, the great idol of mankind, would lose its value, and we should prize it only for its scientific teaching."

Figure 287.

Portrait of Theophrast Bombast von Hohenheim, called Paracelsus (1493–1541), from an engraving by Gaywood after Rubens.

There was a maxim beloved by all the alchemists, which briefly formulates the basic principle of their system. It runs: "What is below is as that which is above, what is above is as that which is below." The alchemistic theory of the Cosmos was mystical, it asserted the unity of all things and relied chiefly on analogy as its organon of thought. In particular, the alchemists believed that there was an analogical relation between the metals and man as a spiritual being. They attempted to transfuse mystical theological doctrines concerning man and his destiny into physics, explaining the properties and behaviour of metals and other substances by means of such doctrines physically interpreted.

Their elements (earth, water, air and fire) were not different sorts of matter, but different properties manifested by the one matter. Mystical theology asserts that man is triune, consisting of body, soul (=will and affections) and spirit (=intelligence). The alchemists were, therefore, led to the idea that there are three principles in the metals, generated by the four elements, namely salt (principle of stability and resistance), sulphur (principle of combustion and colour), and mercury (the essentially metallic principle). Moreover, still following mystical theology and arguing by analogy, they asserted that, whilst there is only one mercury, there are two sulphurs, one inward and pure, the other outward and gross; and that gold, the most perfect metal, is produced when pure mercury is matured by the action of pure, inward sulphur. Of course, this notion of three principles underlying all things, like the other alchemistic hypotheses, was not formulated at once, but was the result of many generations of speculative thought. This particular notion became very generally believed in after Paracelsus's vigorous championship of it. (See Figure 287.)

In gold, the beautiful metal which entirely resisted the powers of their furnaces permanently to alter its nature, they saw a symbol of perfected humanity, whilst lead, the unlovely metal so readily converted into a "calx" by fire, they regarded as an analogue of unregenerate man. They believed, in accordance with their fundamental principle, that all the metals are produced from one seed in Nature's womb by

* For a fuller discussion of Alchemy and the alchemists, with particular reference to the relation between Alchemy and Modern Science, see the present writer's "Alchemy: Ancient and Modern" (Rider, 1911).

an evolutionary process which works upwards from lead to gold. They believed, further, that man, given the right methods, might assist in this process, producing the final result more speedily. This, the transmutation of the "base" metals into gold, was to be accomplished, they believed, by means of that One Thing which is the origin of, and lies concealed within, all things—not, however, in its pure, transcendent state, but concentrated in a suitable material form. This was the Philosopher's Stone. To achieve the *magnum opus*, as this transmutation was called, was to have gained the One Thing, and to have demonstrated the validity of the alchemistic theory.

In the alchemistic theory of the transmutation of the metals by the aid of that wonderful arcanum, the Philosopher's Stone, we have an attempted physical application of mystical theological doctrines concerning man's regeneration. It is impossible to suppose that so curious a theory as this could have been suggested to the alchemists merely by the results of their chemical experiments. Once formulated, however, many facts (*e.g.*, the apparent transmutation of iron into copper when immersed in a solution of blue vitriol) were noted that could be instanced in support of this and their other curious theories.

Many cases of the supposed transmutation of "base" metals into gold are recorded by the alchemists. Perhaps the most interesting claim to have affected the *magnum opus* is that of John Baptist van Helmont (see Figure 288), a celebrated seventeenth-century chemist and physician, who invented the word *gas*, and was the first chemist to investigate the gas now known as carbon dioxide. He says that he converted quicksilver (eight ounces on one occasion, nine ounces and three-quarters on another) into gold, by the aid of small quantities of a yellow, dense, crystalline powder of unknown composition, which had been given to him by a stranger.[1] Undoubtedly, however, the alchemists were frequently deceived by yellow alloys superficially resembling gold; which may have been the case with van Helmont: lacking definite evidence, definite statements are unwise.

FIGURE 288.

Portraits of J. B. van Helmont (1577–1644) and his son, F. M. van Helmont (1618–1699), from the Frontispiece to J. B. van Helmont's "Oriatrike."

Modern science, which works from facts to theories, not from theories to facts, stands in strong contrast with the science of the ancients. Indeed, the contrast is so great that nowadays many of the theories of the alchemists seem almost unintelligible; and confusion is rendered the worse by their use of diverse and often conflicting symbols and systems of nomenclature. But despite the fantastic mould in which their ideas were cast, as we have indicated already, the alchemists do appear to have intuitively grasped certain fundamental facts, which lost awhile, are being rediscovered by the more certain, if less rapid, methods of modern science. The investigations of radioactivity and allied phenomena have demonstrated that the so-called elements are not immutable, but are one in essence and are produced by an evolutionary process; so the alchemists, in a sense, were right, and the followers of Dalton wrong. As Sir William Tilden remarks: ". . . It appears that modern ideas as to the genesis of the elements, and hence of all matter, stand in strong contrast with those which chiefly prevailed among experimental philosophers from the time of Newton, and seem to reflect in an altered form the speculative views of the ancients."[2] Moreover, recent researches by Sir William Ramsay indicate the possibility of producing true transmutations of the elements, meaning thereby the conversion of one element into another at will, as distinguished from a spontaneous change of one element into another. We shall now briefly discuss these researches.

[1] See J. B. van Helmont: "Oriatrike" (trans. by J. C., 1662), pages 751, 752, and 807.

[2] Sir William A. Tilden: "The Elements: Speculations as to their Nature and Origin" (1910), pages 108, 109.

2. The Researches of Sir William Ramsay.

It is now generally known that Radium (which chemically speaking must be reckoned as an element) spontaneously disintegrates into two other elements, Niton (the radium-emanation, a heavy, chemically-inactive gas) and Helium. Niton behaves in a similar manner, yielding Helium and a solid substance, Radium A, which in its turn also disintegrates. In fact, it appears that there are no "elements" which are perfectly stable, though it is only in these and certain other cases that the amount of disintegration is sufficient to make itself appreciably felt. All such sub-atomic changes, as these may be termed, are accompanied by relatively large energy changes. This is particularly the case with respect to the disintegration of Niton. It has been estimated that the decomposition of one cubic centimetre of Niton is accompanied by the evolution of about four million times as much heat as is obtained by the combustion of an equal volume of hydrogen. It is evident, therefore, that locked up within the chemical atoms there must be a store of potential energy so vast that the human mind can scarce conceive of it. It is a fair inference to suppose that in order to bring about the conversion of one element into another at will, energy at an excessively high potential, in a highly concentrated form, so to speak, such as is obtainable from no ordinary sources, is necessary. In fact, the only energy of this sort available is that given out with the spontaneous decomposition of Niton and other highly radio-active elements. Even then, as the actual quantity of energy given out during ordinary periods of time is comparatively small, owing to the fact that such sub-atomic changes are comparatively slow, it appears that, granting the transmutation of the elements to be possible by this means, only microscopical quantities could be actually transmuted. The only case in which one can suppose transmutation of large quantities of an element as possible, would be in the event of there existing a substance which would catalytically convert one element into another containing less potential energy. There is no inherent impossibility in this latter supposition; but, on the other hand, no such catalyst is known. That the energy obtained by the spontaneous decomposition of Niton, however, may be utilised for transmuting microscopical quantities of various elements is indicated by the researches of Sir William Ramsay.

Figure 289.

Photographs of Spectra (Ramsay).

A, Pure Helium; B, Iron-Arc; C, Gases under examination (2nd photograph); D, Gases under examination (1st photograph); E, Pure Neon.

His first experiments were carried out on distilled water, and the result confirmed later by a more accurate experiment carried out in conjunction with Mr. Cameron.[*] In this experiment the water, upon which a small quantity of Niton was allowed to act, was contained in a silica-bulb. The gases produced were removed: these consisted mainly of oxygen and hydrogen, due to the chemical decomposition of the water. The residual gas, after removing the ordinary gases, was examined spectroscopically. Helium was present, owing to the disintegration of the Niton in the gas-phase in the bulb; but besides the Helium lines, the characteristic lines of Neon were also observed. This is shown in Figure 289, which is here reproduced from *The Journal of the Chemical Society* by kind permission of Sir William Ramsay, to whom the present writer's thanks are due. A is the spectrum of pure Helium; B, that of the iron arc; C and D are different photographs of the gases under examination[†]; whilst E is the spectrum of pure Neon. Ramsay and Cameron conclude their paper as follows: "We must regard the transformation of emanation into Neon, in presence of water, as indisputably proved, and, if a transmutation be defined as a transformation brought about at will, by change of conditions, then *this is the first case of transmutation of which conclusive evidence is put forward.*"

The same chemists also carried out similar experiments, in which a salt of copper was added to the

[*] *Journal of the Chemical Society*, Vol. XCI (1907), pages 931 *et seq.*, Vol. XCIII (1908), pages 966 *et seq.*

[†] Regarding these photographs the authors write, "The reproduction only shows some of the strongest red lines of neon in C and D. The helium and neon yellow lines appear as one thick line in the reproduction, although on the plate they are seen to be distinct." The photograph C was taken after D, when many of the neon lines had faded.

water.* After removing the copper, spectroscopic analysis revealed the presence of a considerable quantity of Sodium, together with traces of Lithium. In the case of copper nitrate the gas obtained showed the presence of Argon, but no Helium.

Another series of experiments have been carried out by Sir William Ramsay alone and in conjunction with Mr. F. L. Usher on the action of Niton on solutions of compounds (not containing carbon) of Silicon, Titanium, Zirconium, Thorium and Lead.† In every case, save that of lead, carbon dioxide was produced. Sir William Ramsay also obtained carbon dioxide by the action of Niton on a solution of bismuth perchlorate.

In all these cases it will be noted that the element obtained is of a lighter atomic weight than that which is disintegrated, and that, save in the case of the transmutation of bismuth into carbon, the element produced is always one occurring in the same column of the Periodic Table as that from which it is obtained. Thus Helium (3·99), Neon (20·2), Argon (39·88), and Niton (222·4) occur together in column 0; Lithium (6·94), Sodium (23·00), and Copper (63·57) in column I; and Silicon (28·3), Titanium (48·1), Zirconium (90·6), and Thorium (232·0) in column 4. No case has yet been observed in which an element appears to be transmuted into one of higher atomic weight; though there is no inherent reason, if we can "degrade" elements, why we should not be able to build them up.

Professor Rutherford and Mr. Royds, who have also examined the action of Niton on water, question the validity of Sir William Ramsay's conclusions, and suggest that the presence of Neon in his experiments was due to leakage of air into the apparatus.‡ But in a further experiment by Ramsay, described at a recent meeting of the Chemical Society, the quantity of Neon obtained, compared with that of Argon, was far in excess of what would have been present had it been due only to leakage. No one can read the accounts of Sir William Ramsay's experiments without being impressed by the careful attention bestowed to those small details whose neglect spells error. The first step only has been made into a new realm of science, and no doubt conclusions will have to be modified as progress is made. But, taken as a whole, these experiments do indicate that the transmutation of the elements is not merely an idle dream, as was at one time supposed.

* *Journal of the Chemical Society*, Vol. XCI (1907), pages 1593 *et seq.* The transmutation of copper into lithium is disputed by Madame Curie and Mademoiselle Gleditsch.

† *Journal of the Chemical Society* (1909), Vol. XCV, pages 624 *et seq.*; and *Chemical News* (1909), Vol. C, page 209.

‡ *Philosophical Magazine* (1908) (6), Vol. XVI., pages 812 *et seq.*

A NEW SIDEREAL WATCH.

A CORRESPONDENT writes :—It may interest your readers to know that the Waltham Watch Company have lately placed on the market an excellent sidereal watch. (See Figure 290.) The movement is in every way first class and fully jewelled, and when tested by transit observations the rate is exceedingly close. The seconds dial is large and plain so that, using Herschel's method of counting, time may be easily taken to about a fifth of a second for each wire. A professional astronomer would find it just the thing for a deck watch to carry about with him, whilst it would serve every purpose of the amateur and obviate the necessity for a sidereal clock. It has, of course, a compensation balance, and is corrected for temperature and for all five positions. It is in a dust-proof screw case and costs £10.

The same Company are also making an eight-day lever chronometer (see Figure 291) mounted in a box with gimbals. It has only been out a few months or so. It is sent out duly rated to mean time, and costs £12.

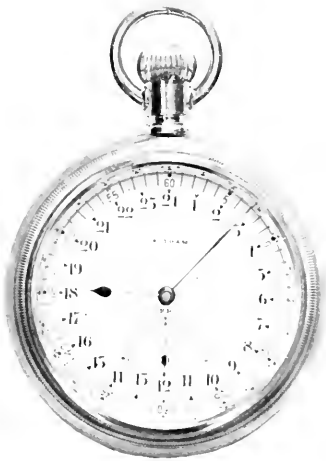


FIGURE 290.

FIGURE 291.

THE FACE OF THE SKY FOR AUGUST.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.		Sun. R.A.	Sun. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	R.A.	Dec.	R.A.	Dec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 26.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	P	B	Jupiter. L_1	Jupiter. L_2	T_1	T_2	Saturn. P	Saturn. B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 27.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T_1 T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN moves South pretty rapidly. Sunrise during August changes from $4^h\ 26^m$ to $5^h\ 13^m$; sunset from $7^h\ 46^m$ to $6^h\ 47^m$. Its semi-diameter increases from 15′ 47″ to 15′ 53″.

MERCURY is an evening Star till the 22nd, when it passes Interior Conjunction and becomes a morning star. On August 1st, one third of disc is illuminated, semi-diameter $4\frac{1}{2}''$; on August 31st, one sixth of disc is illuminated, semi-diameter $4\frac{1}{2}''$.

VENUS is an evening Star, but too near the Sun for convenient observation. Illumination nearly complete, semi-diameter 5″.

THE MOON. Last Quarter $6^d\ 4^h\ 18^m m$; New $12^d\ 7^h\ 58^m e$; First Quarter $19^d\ 4^h\ 57^m e$; Full $27^d\ 7^h\ 59^m e$. Perigee $12^d\ 10^h m$, semi-diameter 16′ 44″; (only 3″ less than the very high value last January); Apogee $25^d\ 0^h m$, semi-diameter 14′ 44″. Maximum Librations, August 6^d, 8° E., 10^d 7° S., 18^d 8° W., 23^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is an evening Star, but practically invisible.

JUPITER is an evening Star, increasing its distance from us, so that the equatorial semi-diameter diminishes from $20\frac{1}{2}''$ to $18\frac{1}{2}''$. The Polar is smaller by $1\frac{1}{3}''$. The configurations of the satellites at 9^h e are for an inverting telescope (see Table 29).

Satellite phenomena visible at Greenwich, $3^d\ 9^h\ 50^m$ III. Tr. E., $9^h\ 58^m$ II. Tr. I., $11^h\ 25^m$ I. Oc. D.; $4^d\ 8^h\ 39^m$ I. Tr. I., $9^h\ 50^m$ I. Sh. I., $10^h\ 53^m$ I. Tr. E.; $5^d\ 9^h\ 15^m\ 57^s$ I. Ec. R., $9^h\ 37^m\ 25^s$ II. Ec. R.; $11^d\ 10^h\ 31^m$ I. Tr. I.; $12^d\ 7^h\ 44^m$ I. Oc. D.; $13^d\ 8^h\ 29^m$ I. Sh. E.; $14^d\ 8^h\ 43^m\ 34^s$ III. Ec. R.; $19^d\ 9^h\ 37^m$ I. Oc. D., $9^h\ 37^m$ II. Oc. D.; $20^d\ 8^h\ 10^m$ I. Sh. I., $9^h\ 7^m$ I. Tr. E., $10^h\ 24^m$ I. Sh. E.; $21^d\ 7^h\ 34^m\ 15^s$ I. Ec. R., $7^h\ 35^m$ III. Oc. R., $9^h\ 26^m$ II. Sh. E.; $27^d\ 8^h\ 47^m$ I. Tr. I., $10^h\ 5^m$ I. Sh. I.; $28^d\ 9^h\ 13^m$ III. Oc. D., $9^h\ 20^m$ II. Sh. I., $9^h\ 28^m$ II. Tr. E., $9^h\ 29^m\ 7^s$ I. Ec. R.; $30^d\ 6^h\ 49^m\ 42^s$ II. Ec. R.

All the above are in the evening hours.

The eclipse reappearances of I. II. and both phases of those of III. occur high right of the inverted image, taking the direction of the belts as horizontal.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912			h. m.		h. m.	
Aug. 6	30 Arietis	6·5	2 35 *m*	59	3 45 *m*	238
„ 16	B.A.C. 4304	5·6	7 20 *e*	170	8 5	247
„ 22	Lacaille 7730	7·0	8 47 *e*	88		
„ 22	Lacaille 7759	7·0	10 30 *e*	90		
„ 23	B.A.C. 6628 ...	5·9	9 59 *e*	25	10 52 *e*	305
„ 29	B.D. 7 6612	7·0			2 0 *m*	233
„ 31	B.A.C. 274	6·3	0 0 *m*	332	0 12 *m*	320

TABLE 28. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

SATURN is a morning Star. Polar semi diameter 8½″. The major axis of the ring is 41½″, the minor axis 17¼″. The ring is now approaching its maximum opening, and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). August 3^d $4^h{\cdot}2$ *m*, 10^d $5^h{\cdot}5$ *e*, 18^d $0^h{\cdot}8$ *m*, 25^d $8^h{\cdot}0$ *e*, September 2^d $0^h{\cdot}3$ *m*. Dione (every third given). August 3^d $5^h{\cdot}9$ *m*, 11^d $11^h{\cdot}1$ *m*, 19^d $4^h{\cdot}2$ *e*, 27^d $9^h{\cdot}3$ *e*.

Rhea (every second given). August 4^d $11^h{\cdot}4$ *e*, 14^d $0^h{\cdot}5$ *m*, 23^d $1^h{\cdot}3$ *m*, September 1^d $2^h{\cdot}3$ *m*.

For Titan and Iapetus, E., W. means East and West elongations, I., S. Inferior and Superior Conjunction, Inferior being to the North, superior to the South. Titan, 4^d $7^h{\cdot}8$ *m* S., 8^d $11^h{\cdot}5$ E., 12^d $0^h{\cdot}7$ *e* I., 16^d $8^h{\cdot}[illegible]$ *m* W., 20^d $7^h{\cdot}6$ *m* S., 24^d $11^h{\cdot}2$ *m* E., 28^d $0^h{\cdot}2$ *e* I., September 1^d $8^h{\cdot}2$ *m* W. Iapetus 5^d $4^h{\cdot}8$ *m* S., 25^d $6^h{\cdot}7$ *e* E.

URANUS is an evening Star, semi-diameter 2″. It is 7½° South of Alpha Capricorni, 5° South West of Beta.

NEPTUNE is invisible.

Day.	West.	East.	Day.	West.	East.
Aug. 1	12	34	Aug. 17	1	4
.. 2		13	.. 18		14
.. 3	1	○	.. 19	32	4
.. 4	3		.. 20	34 ⊙	2
.. 5	43	2● ●	.. 21	42	31
.. 6	431	2	.. 22	421	3
.. 7	42		.. 23	4	3
.. 8	4	3	.. 24	41	
.. 9	4	123	.. 25	4	1
.. 10	41		.. 26	431	
.. 11	324	1	.. 27	34 ⊙	2
.. 12	3	4 2● 1●	.. 28	⊙	1●
.. 13	31	24	.. 29	21	43
.. 14	2	4	.. 30		1 34
.. 15	21	34	.. 31	1	4
.. 16		1234			

TABLE 29.

CLUSTERS AND NEBULAE.

Name.		R.A.		Dec.	Remarks.
M	56	19	13ᵐ	N 29 ·1	Globular cluster.
H IV	51	19	38	S 14 ·3	Planetary nebula.
M	71	19	49	N 18 ·6	Faint cluster, 1° S.W of γ Sagittae.
M.	27	19	55	N 22 ·5	The Dumb Bell nebula in Vulpecula.
M.	75	20	0	S 22 ·2	
H VII	59	20	1	N 43 ·8	Cluster.
H VIII.	56	20	20	N 40 ·4	Cluster, ½° N.E. of γ Cygni.
H I	103	20	20	N 7 ·[illegible]	
H IV.	1	20	59	S 11 ·7	Remarkable planetary nebula.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.		Remarks.
	R.A.	Dec.	
May 30 to Aug.	333	− 28	Swift, streaks.
June to Aug.	310	− 01	Swift, streaks.
June to Sept.	335	+ 57	Swift.
June to Aug.	303	− 24	Swift.
July to Aug.	308	12	Slow, long.
July 25 to Sept. 15	48	+ 43	Swift, streaks.
July to Sept.	335	+ 73	Swift, short.
July to Aug.	280	+ 57	Slow, short.
July to Oct.	355	+ 72	Swift, short.
Aug. 10–13	45	+ 57	Perseids. Swift, streaks.
Aug., Sept.	353	11	Rather slow.
Aug. 15	290	+ 53	Swift, bright.
.. 15–25	291	− 02	Slow, bright.
.. 25	5	+ 11	Slow, short.
Aug., Sept	340	0	Slow.
Aug. to Oct. 2	74	42	Swift, streaks.
Aug., Sept	03	− 22	Swift, streaks.

DOUBLE STARS.—The limits of R.A. are 19ʰ to 21ʰ.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
17 Lyrae ...	19 4	N 32 ·4	5½, 9½	310°	3	Yellow, blue.
Groombridge 2786	19 10	N 49 ·7	6, 6	217	0	Yellow.
η Lyrae	19 11	N 39 ·0	4, 8	83	28	Blue, ash.
23 Aquilae	19 11	N 0 ·9	5½, 9½	8	3	Yellow, blue.
δ Cygni ...	19 42	N 44 ·9	3, 8	297	1½	White, blue.
ζ Sagittae	19 45	N 19 ·0	6, 9	310	9	White, blue.
The principal star is a very close double, ¼″ apart.						
ε Draconis	19 49	N 70 ·1	4, 7½	10	3	Yellow, blue.
ψ Cygni ...	19 54	N 52 ·2	5, 7½	181	3	White, ash.
θ Sagittae ...	20 6	N 20 ·7	6, 8	327	11	Yellow, ash.
There is a 7th mag. star 1′ away.						
Groombridge 3142	20 10	N 55 ·2	6, 7	337	3	White, ash.
κ Cephei	20 13	N 77 ·5	4, 8	123	7	Green, blue.
γ Delphini	20 43	N 15 ·9	4, 5	269	11	Orange, green.
4 Aquarii ..	20 47	S 5 ·9	6, 7	310	1	Yellow.
Period 130 years.						
ε Equulei	20 55	N 4 ·0	5½, 6	286	1	Yellow.
Also a 7th mag. at 73 10″.						
Piazzi xx, 429	20 59	N 50 ·2	6, 7½	32	2	White.
12 Aquarii ...	20 59	S 6 ·1	5½, 7½	193	2½	Yellow, blue.

TABLE 30.

REVIEWS.

BACTERIOLOGY.

Microbes and Toxins. By Dr. Etienne Burnet (of the Pasteur Institute, of Paris), with a preface by Elie Metchnikoff. Translated from the French by Drs. C. Broquet and W. M. Scott. xvi + 316 pages. 7½ in. × 5 in.

(W. Heinemann. Price, 5/- net.)

The writing of a booklet on some technical subject which shall be interesting and intelligible to the educated public and also correct and which shall at the same time assume no previous knowledge of this or kindred subjects, is a much more difficult task than might at first sight appear, and few who have the requisite knowledge have the necessary patience to carry it through.

The writer of the book before us is eminently qualified for the work he has undertaken, and has succeeded in making every page of it both interesting and easily intelligible. A short summary of its contents precedes each chapter so that it is easy to find any details for which we are seeking. Inflammation, immunity, antitoxins and vaccines and a host of similar subjects are, of course, dealt with. But besides these, reference is made to subjects of more general interest. The bacteria of coal, the root nodules by which certain plants are able to abstract the nitrogen from the air, and the lactic bacteria which ferment milk are all described. It may be news to some of us that our large intestine is "not only a useless but an injurious organ," but the author assures us that this is so and maintains his point well. By far the best general account of the microbes of health and disease that we have yet seen, is contained in the volume before us.

S. H.

BIOLOGY.

The Origin of Life: being an account of experiments with certain superheated saline solutions in hermetically sealed vessels. By H. Charlton Bastian, M.D., F.R.S. 76 pages. 10 plates. 10-in. × 6¼-in.

(Watts & Co. Price 3/6 net.)

It is somewhat difficult to know just what to say about a book like this, in which the fundamental axiom of biology, "omne vivum ex vivo," is boldly challenged—moreover, a book written, not by a dabbler, but by a trained man of science, and a Fellow of the Royal Society to boot—and in which the author sets out in detail the methods and results by which he has proved, to his own satisfaction, at any rate, that under certain conditions, living organisms arise from dead and even inorganic matter by spontaneous generation.

As the question of spontaneous generation, or abiogenesis, is usually regarded nowadays as a matter of purely historical interest, and as the author of this book has not dealt with the earlier history of the question, it may be worth while to consider this. Briefly, the doctrine of spontaneous generation was held by the ancient naturalists from Aristotle onwards, and after being severely shaken by Redi in 1668, was revived by Needham in 1748, still more severely shaken by Spallanzani, Franz Schultze, and Schwann between 1775 and 1837, revived again by Pouchet in 1859, and finally (as most biologists hold) disposed of altogether by Pasteur and Tyndall between 1860 and 1876.

For at least two thousand years, from Aristotle (325 B.C.) to Redi's time, it was firmly believed that rats and mice were "begot of the mud of Nylus," dew gave rise to insects, worms were generated in cheese and timber, beetles and wasps in dung, and so on; though from time to time there were those who had their doubts about all this, like Sir Thomas Browne. Until Redi made his simple and crude experiments, apparently no one had attempted to test the truth or otherwise of spontaneous generation. Redi exposed meat in jars, some left open, others covered with parchment and others with fine wire gauze. The meat in all the jars became spoiled, of course, and flies, attracted by the smell, laid their eggs in that left uncovered, a crop of maggots arising therefrom; in the case of the covered vessels the flies laid their eggs on the gauze but no maggots appeared on the meat itself. Redi concluded that all supposed cases of spontaneous generation were due to the introduction of living germs from outside. Huxley remarks of Redi's work, "the extreme simplicity of his experiments, and the clearness of his arguments, gained for his views and for their consequences almost universal acceptance."

So far as larger organisms were concerned, therefore, Redi may be said to have settled the question of biogenesis *versus* abiogenesis. Soon after Leeuwenhoek discovered the existence of bacteria, in 1687, spontaneous generation was again invoked—this time in order to account for the origin of microscopic organisms. The first experimental test, apparently, was made by Needham (1748), who extracted meat-juice by boiling, enclosed it in vials which he corked and sealed, then heated the sealed vials and set them aside; in course of time the juice was found to swarm with bacteria, and as Needham believed he had killed all living germs in the juice by repeated heating, he concluded that the organisms had arisen by spontaneous generation. Spallanzani, in 1775, first made use of narrow-necked glass flasks in the experimental study of the question, arguing that Needham's methods were careless and insufficient, and that it was better to use vessels which could be hermetically sealed. Spallanzani worked with scrupulous care and precision, placing vegetable infusions and meat juice in his flasks, sealing the necks in a flame, and immersing the flasks in boiling water for about an hour in order to destroy any germs that might be already present. His infusions remained unchanged, and he drew the obvious conclusion that even microscopic organisms are not spontaneously formed in nutrient fluids. Needham objected to these results, maintaining that prolonged boiling would destroy not merely germs but also the "vegetative force" of the infusion itself; but Spallanzani easily disposed of this objection in his later experiments by showing that when the infusions were again exposed to the air, no matter how severe or prolonged the boiling to which they had been subjected, the organisms appeared.

Now we come to what, until the appearance of Bastian's books, was generally considered to be the final phase in this controversy. The discovery of oxygen by Priestley in 1774 gave rise to doubts as to the conclusive nature of Spallanzani's work—oxygen, it was argued, is necessary for active life, and the boiling of the flasks might have driven out the oxygen. Hence it became necessary to experiment under conditions in which the nutrient fluids are made accessible to the atmosphere. Franz Schultze in 1836, and Theodor Schwann in the following year, devised apparatus in which air was drawn through sulphuric acid, or heated strongly, on its way into the nutrient fluid; both of these experimenters took care to have their flasks and fluids thoroughly sterilised, and their experiments showed that the latter remained uncontaminated. Once again, however, the question was opened up, by the publication in 1859 of Pouchet's experiments; but Pasteur's brilliant researches of 1860 and succeeding years proved that, ingenious though Pouchet's experiments undoubtedly were, they were marred by several sources of error—that is, he had left several loopholes for the entry of germ-laden dust into his fluids. Finally, in 1876 Tyndall made his classical and crucial tests with "optically pure" air, and—at any rate for the majority of biologists—the doctrine of spontaneous generation was ejected from its last stronghold.

As remarked by Locy ("Biology and its Makers," 1908), the work of Pasteur and Tyndall "showed that under the conditions of the experiments no spontaneous origin of life takes place. But while we must regard the hypothesis of spontaneous generation as thus having been disproved on an experimental basis, it is still adhered to from the theoretical standpoint by many naturalists; and there are also many who think that life arises spontaneously at the present time in ultra-microscopic particles. Weismann's hypothetical 'biophors,' too minute for microscopic observation, are supposed to arise by spontaneous generation. This phase of the question, however, not being amenable to scientific tests, is theoretical, and therefore, so far as the evidence goes, we may safely say that the spontaneous origin of life under present conditions is unknown."

Dr. Bastian's claims are not likely to meet with much sympathy, or any acceptance from the majority of biologists. Still, one may admire his courage in publishing at the present day a circumstantial account of experiments in which he claims to have proved conclusively that not only bacteria and "torulae" (obsolete term for saccharomycetes or yeasts), but even ascomycetous fungi (penicillium — with full-grown mycelium, gonidiophores, and all!), appear *de novo* in absolutely sterilised solutions. The mystified reader may well exclaim, in the language of Truthful James (slightly paraphrased)—"Do I sleep? Do I dream? Do I wonder and doubt? Are things what they seem? Or is visions about? Is our bacteriology a failure? Or is pasteurisation played out?"

Without attempting a detailed analysis of this remarkable book, we should like to mention for the consideration of the numerous readers who are always attracted by the heterodox and the startling, in science as in all other branches of thought, a few of the many points arising from a perusal of this heterodox and startling volume. It is generally agreed that the yeasts have arisen—by reduction and by adaptation to life in, and fermentation of, saccharine solutions—from higher ascomycetes, that is to say, from a highly-organised group of fungi, which has unquestionably had a long phylogenetic history. Yet these organisms are said by the author to arise *de novo* and in abundance in sterilised solutions containing no trace of organic substance of any kind. It is not quite certain from which particular group of ascomycetes the yeasts have actually arisen; but in any case our amazement is not lessened when we learn that an ascomycetous fungus, the familiar and ubiquitous penicillium, is also regarded as an organism which suddenly appears in the same way in absolutely sterilised inorganic media. Now, botanists are generally agreed that the ascomycetous fungi have most likely arisen from the red algae, and that penicillium has doubtless passed through an even longer evolutionary history than the yeasts. If the author's observations could be proved, we should have proof not merely of spontaneous generation but also of *evolutio per saltum* with a vengeance—mutation of a kind far beyond the wildest dreams of the mutationists. The organisms which are supposed to have arisen by spontaneous generation in Bastian's cultures, it should be noted, are just those which are the bane of the careless bacteriologist—bacilli, yeasts, penicillium, and so on.

We should like to see experiments like those described in this book done on a large scale—if they can be done in small vials and flasks, why not in huge vessels containing a few hundred gallons of the sterilised solution? It would then be possible to test the author's claims in a simple and conclusive manner—the organisms could be separated from the solution and chemically analysed. The author states, by the way, that he used pure solutions of sodium silicate. If it could thus be absolutely proven that the solution was entirely free from the slightest traces of carbon, nitrogen, sulphur, and phosphorus, the crucial question would be—do the "abiogenetic" organisms contain these elements, which we have hitherto regarded as universal and essential constituents of the living substance protoplasm? If they do, then we should have a result transcending in scientific interest, and more truly epoch-making than, the mere trifle of highly-organised fungi appearing by spontaneous generation in a sterilised organic infusion. Perhaps, however, it would not be necessary to work upon such a large scale—though the idea of so doing appeals to us, on the principle of eliminating "experimental error," as strongly as did that of estimating the frequency of butting of bull-calves to the professor of physiology in "The Food of the Gods"! A skilful chemist could easily settle the question by a series of microchemical tests. But apparently these, and various other, aspects of the matter did not occur to the author of this remarkable work.

The fact is, that with every intention of judging the author's results and interpretations in a candid and unbiassed spirit, we find throughout the work glaring instances of neglect to take obvious precautions and to make really scientific tests, and therefore we have no alternative but to reject these results and interpretations, as most emphatically "not proven."

F. C.

BOTANY.

The Life of the Plant. By C. A. Timiriazeff. 355 pages. 83 illustrations. 9½-in. × 5¾-in.

(Longmans, Green & Co. Price 7/6 net.)

This book has been translated from the seventh Russian edition by Miss Anna Chéréméteff, who deserves the warmest praise for the arduous task which she has so skilfully and successfully undertaken. Our sole regret is that this admirable work was not long ago done into English—it was first published in Russian in 1878. We have for years sought in vain for a French or German edition, and not having been able to learn of any translation had almost resolved to learn Russian in order to peruse what we felt sure must be an exceptionally interesting book, worthy of the high reputation of the author as a plant physiologist! The perusal of this belated English version has more than confirmed our expectations, for this is a work of the highest interest for teachers and students of Botany. Timiriazeff's researches, in particular those on chlorophyll and photosynthesis, have become classical, and that he is a master of the art of exposition is shown in his Croonian Lecture to the Royal Society in 1903 on "The Cosmical Function of the Green Plant" (*Proc. Roy. Soc.*, vol. 72, 1903, pp. 424-461).

The book is based on a course of semi-popular lectures delivered in Moscow during the winter of 1876, and are written in a delightfully free, in places colloquial and even humorous, style which makes them exceedingly good reading. The introductory portion of Chapter (or Lecture) I. contains some pointed and pithy remarks on the general public's meagre knowledge of botany (for which, as the author very justly says, the fault lies partly with botanists themselves and partly with the historic development of this branch of science) and the two old-fashioned types of botanists, the "pedantic nomenclator" and the amateur horticulturist or "elegant adept of the *amabilis scientia*, as botany was called in olden times," both of whom are still "botanists" to the public of to-day, including even well-educated people not conversant with science. Equally enjoyable are the author's gentle sarcasm concerning the type of botanical work which is "hackneyed and suitable only for children's books or for occasional illustrated publications for grown-up people"; his gibes at the botanical marvels and absurdities appearing now and then in the daily newspapers; his reflections concerning the backward condition of vegetable physiology as compared with morphology, and the reasons for this; and the interesting comparison which he draws between the historical development of animal physiology and that of vegetable physiology; and so on.

After this stimulating introduction, the author proceeds to the consideration of the general structure of plants, the cell, seeds, roots, leaves, stems, growth, flowers, the relation between plants and animals, and the origin of organic forms; and in an appendix gives an account of "the plant as a source of energy," which is on similar lines to his Croonian Lecture already referred to.

Throughout, the idea expressed in the title—"the life of the plant"—is kept consistently to the front, and many experiments (some of them exhibiting extreme ingenuity) are described. Most of these experiments were shown to the fortunate audience attending the author's course of lectures, over which he must have taken infinite pains—and which he evidently delivered with great gusto.

Without entering upon a detailed analysis, it may be said that this book is one which will not only be read with pleasure and profit by botanical teachers and students, but is one of the very few comprehensive botanical works which can be recommended to the educated reader whether or not conversant with botanical science. Of all recent botanical publications in English, this is *the* book for general readers who want something better than the "talky talky" and "pretty pretty" sort of "popular Botany," something that will (without either going above their heads or insulting their intelligence) give them such an insight into plant life as can only be given by a writer who has himself contributed notably to the advancement of his chosen branch of science and who also possesses in a marked degree the happy facility of imparting his knowledge in a clear and graceful style.

F. C.

Botany. By MARIE STOPES. 94 pages. 5 figures. $6\frac{1}{2}$-in. × $4\frac{1}{4}$-in.

(T. C. & E. C. Jack. Price 6d. net.)

This is one of the remarkably cheap little "People's Books" introduced by Messrs. Jack. To compress into ninety pages a general account of the several divisions of "Botany, or the modern study of plants"—morphology, anatomy, physiology, ecology, palaeontology, and so on—is a formidable undertaking, and the authoress may be congratulated on having attempted the almost impossible and done it successfully. In less skilful hands, the result might have been somewhat incoherent and unreadable, but this little book is extremely readable, and gives an admirable bird's-eye view of the subject-matter and aims of the various branches into which botanical science has for convenience been necessarily divided. It will form an excellent general introduction to works in which these various departments are dealt with by specialists. There are a few slight inaccuracies and obscure statements; for instance, the tendrils of ampelopsis are branches (modified inflorescences), not leaves, and the name of the remarkable pitcher-plant which provides its own flower pots is misprinted *Discidia*, for *Dischidia*. Instead of printing on a separate slip the introduction in which the authoress tersely describes the scope and aims of her little book, the publishers might either have incorporated it in the book (the reader can, of course, remedy this defect by the aid of a paste brush) or have printed on the title-page as a suitable motto a slight adaptation of Juvenal's "quicquid agunt *botanici* nostri farrago libelli."

F. C.

A Manual of Structural Botany.—By HENRY H. RUSBY. 248 pages. 599 illustrations. $9\frac{1}{2}$-in. × 6-in.

(J. & A. Churchill. Price 10/6 net.)

The author states in his preface that this volume "which is a condensed but fairly complete introduction to Botany, and is suitable as a text-book for academic or collegiate students, has been written with special reference to the needs of the first year student of pharmacy, as a preparation for his second year work in pharmacognosy." From the high official positions held by the author in the American pharmaceutical world, we may infer that the curriculum outlined in this book represents the kind of botanical course which is considered necessary and sufficient for the American student of pharmacy. If so, we may congratulate ourselves that in this respect at any rate we are far ahead of our American cousins and have nothing useful to learn from them. Judged as a "fairly complete introduction to Botany," this is probably the most tedious, arid, stodgy, pedantic, uninspiring, stale, flat and unprofitable work published in modern times. Had the work been entitled "A Dictionary of Botanical Terms," it would be a very different matter, for it certainly gives a wonderfully complete collection of terms, with explanations and diagrams. It would be difficult to think of a single descriptive term in the fearsome vocabulary accumulated since the days of the mediaeval herbalists which cannot be found in this volume. Imagination staggers at the picture of the American pharmacy student's task of mastering this "fairly complete introduction to Botany," with blood-shot eyes and a splitting headache which no wet towel applications can assuage. Surely even a pharmaceutical student should be taught that Botany is Plant Biology, the study of the life of plants. This high-and-dry morphology and terminology, with hardly even a passing reference to function and life processes, cannot be accepted as the right sort of botanical curriculum for any class of student, whether he be preparing for a medical or pharmaceutical diploma or taking the subject as part of a general training in science or arts. Surely the best course of botanical work for every purpose is one in which form and function are studied hand in hand and recognised as mutually explanatory. Of course, to understand the physiology of plants it is necessary to study their form and structure, just as it is essential to study the construction of a machine in order to understand aright its working; but, on the other hand, the study of plant organs apart from their functions is, like the study of the parts of a machine without any reference to their uses, a tedious and fruitless pursuit. The attempt to study the plant exclusively from one or other of the two arbitrary points of view of morphology and physiology is not merely illogical—it cannot even be strictly applied or carried to a logical conclusion. Still, this impossibility is occasionally attempted, as in the present work.

However, while protesting against the claim of this type of botanical text-book to be regarded as a "fairly complete introduction to Botany," one may recommend it as a work of reference and as a morphological treatise which may be useful as an adjunct to works in which plant-life is treated from the biological point of view.

F. C.

CHEMISTRY.

Electro Analysis.—By E. F. SMITH. 332 pages. 46 illustrations. $7\frac{1}{2}$-in. × 5-in.

(Kegan Paul & Co. Price 10/6 net.)

The simplicity, rapidity and accuracy of electrolytic methods of analysis would naturally appeal to the American mind, and it is therefore not surprising that a large proportion of these processes should have been worked out in America. Professor Smith is well known for his contributions to this branch of chemical analysis, and the present book, which has deservedly reached its fifth edition, embodies much of his work upon the subject; while the reader has the advantage of knowing that all the methods described have been given a practical trial by the author. The new material in this edition includes all the important processes and modifications that have been published in scientific journals during the past four years, including the methods for the electrolytic separation of the alkali metals. There is a good index, but the references to the original papers are somewhat scanty.

C. A. M.

A First Year Physical Chemistry.—By T. P. HILDITCH, D.Sc. (Lond.), F.I.C. 176 pages. 57 illustrations. $7\frac{1}{2}$-in. × 5-in.

(Methuen & Co. Price 2s.)

Although several books dealing with the physics of chemistry have recently been published, we are not acquainted with any that covers quite the same ground as this useful little manual. While it is essentially intended for the work of a first year course in chemistry it is yet quite advanced enough for the use of those who are working for "Intermediate Science" examinations. Even in the more abstruse parts the text is simply expressed and is not too didactic. Practical work goes hand in hand with theory, and the experiments are well chosen and described, and wherever there was likely to be any want of clearness, diagrams of the apparatus are given.

The book will be found of the greatest assistance by all who are beginning the study of chemistry, and should be used as a companion to the ordinary elementary text books.

C. A. M.

Organic Chemistry.—By W. H. PERKIN, Sc.D., F.R.S., and F. S. KIPPING, Sc.D., F.R.S. 664 pages. $7\frac{1}{4}$-in. × 5-in.

(W. & R. Chambers. Price 7/6.)

Many generations of students have availed themselves of the valuable help of this well-known textbook, and the present reviewer has, on several occasions, recommended it as one of the most suitable books as introductory guide to organic chemistry. In many respects the present edition may be regarded as a new book; for it has been thoroughly revised and brought up to date, so as to include the results of the most recent work in this branch of the science. At the same time the plan and character of the work have been kept, so that while the book will now be more helpful to advanced students and for those studying medicine, it still remains an excellent guide for the beginner

As in the former editions practical work is given its due position, and numerous experiments are described in illustration of the theoretical matter. Practical applications of chemical reactions are also described in brief outline, and usually in sufficient detail for the purpose in hand.

We have noticed very few slips, but are the authors correct in stating on page 172 that fatty acids containing an odd number of carbon atoms do not occur in nature? Within the last few years it is claimed that several such acids (e.g., daturic acid) have been discovered.

C. A. M.

Organic Chemistry.—By J. E. Cohen, B.Sc., F.R.S. (The People's Books). 96 pages. 4 illustrations. $6\frac{1}{2}$-in. × $4\frac{1}{2}$-in.

(T. C. & E. C. Jack. Price 6d. net.)

Professor Cohen has undertaken a most difficult task in attempting to compress into a little book of ninety-six pages the whole subject of organic chemistry in such a way that it may be understood by anyone without special chemical knowledge.

Although parts of his book will answer to this requirement, we cannot help feeling that in other places he is unnecessarily abstruse, and also goes into too much detail. For instance, on page 21, a table of the physical properties of homologous hydrocarbons is given, whereas it seems to us that the space might have been better utilised (for the end in view) with a fuller explanation in simple language of the meaning of the term *homologous.*

Outlines are given of some of the principal industries based on reactions in organic chemistry and, in general, these are clear and accurate. It is a pity, however, that the author has fallen into the usual mistake about vinegar-making, and has described incorrectly an obsolete method.

Regarded as a summary for the student of chemistry, the book is admirable, and the price at which it is published in an attractive form is a matter for wonder.

C. A. M.

GEOLOGY.

The Natural History of Clay.—By A. B. Searle. Cambridge Manuals of Science and Literature. 176 pages. 18 illustrations. $6\frac{3}{4}$-in. × 5-in.

(The Cambridge University Press. Price 1/- net.)

The term clay is of popular origin and use, hence its adoption as a scientific term is attended with some little confusion, owing to the great number of possible definitions, all of which are to some extent unsatisfactory. While everybody knows what clay is, it seems impossible to frame a satisfactory definition. Even plasticity is not an invariable property of clay, for some kaolins are devoid of this character. The author of this excellent little manual objects to clay being described as a "mineral," except in a legal sense; but there is no doubt that the word "mineral" is the old, popular and scientific term for any inorganic natural substance. We agree, however, with the statement (page 3) ". . . . . clay is not a mineral, but a rock," if, for "mineral," "mineral-species" is substituted.

The book is about evenly divided between the technology and the geology of clay. The technology of clay is a complex and difficult subject, but the author shews himself perfectly at home in it, much more so than in his geology. A clumsily-worded paragraph on page 52 might lead a reader to suppose that a Carboniferous Limestone clay could be accumulated by the denudation of Coal Measures. The table of "the chief clay rocks, arranged geologically," at the beginning of the book, does not convey much information and might advantageously have been extended.

There is a valuable concluding chapter on the nature of the ultimate clay-material. As the author shows, no finality is yet reached in this difficult problem. There is an irritating multiplicity of uses of the term "clay" in this chapter. Sometimes it means a geological unit, sometimes "true clay" or the mysterious clay-substance, "clayite," or "pelinite." A characteristic example of this confusion occurs on page 139. Many of the terms, however, are concisely defined later on (page 149).

A short bibliography of the more important works on clay, and an adequate index, are provided. This little book may be recommended to all interested in the technological or geological aspects of clay as a concise and well-written introduction to the subject.

G. W. T.

Stanford's Geological Map of Central Europe. $16\frac{1}{2}$-in. × $10\frac{1}{2}$-in. Scale, 1 : 6,336,000.

(E. Stanford. Price 5/-.)

This is a geological map of a part of Europe, reduced from the Carte Géologique Internationale de l'Europe on a scale of one hundred miles to an inch. It includes the region between North Germany and Sardinia, and between Ireland and Hungary. In the colouring all the igneous rocks, of whatever age, are lumped together; as are also the metamorphic. Cambrian and Ordovician, Upper Silurian and Devonian, Carboniferous and Permian, respectively make groups to which one colour is assigned. The terms Ordovician and Upper Silurian are, or should be, mutually exclusive. One should have either Ordovician and Silurian, or Lower and Upper Silurian. Objection might also be taken to the term Broverian as of too local significance to be used to designate the sedimentary series below the Cambrian. The map will be useful for purposes of broad stratigraphical comparison.

G. W. T.

Mineralogy.—Fourth edition. By F. H. Hatch, Ph.D., F.G.S. 253 pages. 124 illustrations. $7\frac{1}{2}$-in. × 5-in.

(Whittaker & Co. Price 4/- net.)

This fourth edition of a popular text-book has been entirely re-written and much enlarged, and is, to all intents and purposes, a new book. A text-book of mineralogy falls naturally into two parts; one dealing with the properties of minerals in general, the other descriptive. Dividing his book in this way, Dr. Hatch deals with the morphological, physical, and chemical characters of minerals in an admirably lucid way considering the complexity and difficulty of presentation of the subject in a small compass. The crystallographical chapter is exceedingly compact and understandable. The trigonal sub-system, however, might have been mentioned when dealing with the hexagonal. Moreover, its most important form, the rhombohedron, is only mentioned in connection with the obsolete conception of hemihedrism, which is retained in the book.

In the descriptive part the minerals are arranged under the heads of rock-formers, ores, salts, and gems. This classification, as the author admits, is not free from inconsistencies, but nevertheless seems to have a practical value and convenience in teaching. A good index makes it easy for the student to look up any particular mineral, notwithstanding its possibly anomalous place in the classification.

G. W. T.

The Mineral Kingdom.—By Dr. Reinhard Brauns, translated, with additions, by L. J. Spencer, M.A., F.G.S. Parts 17–20. 56 pages. 39 illustrations. 12-in. × $8\frac{3}{4}$-in.

(Williams & Norgate. Price 2/- net per part.)

These four recently published parts of this fine work maintain the standard set up by the earlier parts. They are mainly concerned with the rock-forming minerals, the felspars, felspathoids, zeolites, pyroxenes, amphiboles, and micas. Some mention might have been made of the now well-ascertained occurrence of primary analcite in igneous rocks, with the consequent recognition of a series of analcite-rocks analogous to those characterised by leucite and nepheline respectively.

Numerous beautiful plates, some in colour, are issued with these parts. The treatment is, of course, "popular," but the specialist may gain time by consulting this concise and well-illustrated epitome of mineralogy.

G. W. T.

PSYCHICAL RESEARCH.

The Trend of Psychical Research. By H. A. DALLAS. 49 pages. 6-in. × 4¼-in.

(John M. Watkins. Price 6d. net.)

During the thirty years that it has been established, the Society for Psychical Research has accumulated a vast number of facts in the obscure domains of psychology, distinguishing the genuine phenomena from the tricks of "spiritistic" charlatans, thus rendering valuable scientific service to the world. But as Miss Dallas (who is a well-known investigator of these matters) argues, the business of science is not merely to collect data, but also to frame theories in explanation of them. She thinks, and most persons who have studied the subject will agree with her, that the time has now arrived when certain conclusions may be drawn from the data already obtained. These conclusions she formulates as follows:—

"1. The reality of an unseen universe of intelligent life.

2. Man's survival of bodily death.

3. That communication takes place between the (so-called) living and the (so-called) dead."

In the essay under review, which was originally delivered as a lecture to the Quest Society and has been reprinted from *The Quest*, she briefly states some of the evidence upon which these conclusions are based. It is of a most interesting nature, and the writer's arguments are well (if of necessity briefly) put.

H. S. REDGROVE.

ZOÖLOGY.

The Life and Love of the Insect. By J. HENRI FABRE, translated by ALEXANDER TEIXEIRA DE MATTOS. 262 pages. 12 plates. 8-in. × 5½-in.

(Adam & Charles Black. Price 5/- net.)

A great love of nature, an aptitude for painstaking and ingenious research, as well as the power of writing a pleasing description belong to M. Fabre, and all three have been combined to produce the essays which make up this volume. The subject of dung beetles does not at the outset sound inviting, but M. Fabres' account of the sacred beetle and its work, as well as that of the Spanish *Copris* and *Minotaurus typhaeus* is most interesting and delightful. Beetles are not by any means the only creatures dealt with, for the scorpions' courtship is described, as well as the habit of some solitary wasps and bees. The ringed *Calicurgus* should be specially mentioned, which first stings its spider prey in the mouth in order to paralyse the fangs, and then in the body to keep the legs still. M. Fabre digresses to describe Pasteur's call upon him previous to the investigations which the great bacteriologist made on silkworm disease. At that time Pasteur had never seen the cocoon of a silkworm nor did he know that there was a chrysalis inside. We are kindly permitted by Messrs. Black to print one of the illustrations (see Figure 292).

W. M. W.

FIGURE 291.
A Tree Crab, from "The Life of the Crustacea."

FIGURE 292.
The Sacred Beetle, from "The Life and Love of the Insect."

The Life of the Crustacea.—By W. T. CALMAN, D.Sc. 289 pages. 85 figures. 7½-in. × 5¼-in.

(Methuen & Co. Price 6/-.)

Dr. Calman has produced a truly scientific, but at the same time, an eminently readable book, and this because he has picked out from the wealth of his information with regard to Crustacea many points which are of general interest. Some specialists are not capable of doing this, which is a pity, for one of the important ways of advancing any particular branch of science is by attracting new workers into the field. In "The Life of the Crustacea" we are told of Crabs which use a shield, such as the valve of a shell or a mangrove leaf, and carry it about; of forms which rear their young in a brood pouch like the opossum shrimp and the wood-lice; of hermit crabs that live, not in the coiled shell of some dead mollusc, but in a piece of hollow water-logged stem, and are quite symmetrical; not to mention such little-known species as the well-shrimps which dwell in subterranean waters. These and many other subjects are attractively brought before us with the help of some excellent illustrations (see Figure 291, which is reproduced by the courtesy of the Publishers). The question of parasites and messmates is considered, and a chapter added on the economic side of the Crustacea.

W. M. W.

Sea Fisheries, Their Treasures and Toilers.—By MARCEL A. HÉRUBEL, Doctor in Science and Professor at the Institut Maritime. Translated by Bernard Miall. 366 pages. 9-in. × 6-in.

(T. Fisher Unwin. Price 10/6 net.)

We welcome this excellent translation of a valuable book. M. Hérubel has given us a vividly interesting account of the rapidly growing department of applied science which deals with sea-fisheries, with an industry that represents more than £10,000,000 a year in Britain alone. With great skill he has brought together the physical, biological, and economic facts on which sound practice and secure progress must rest. And while he is very generous to British organisation of fisheries (and our faculty of uniting tradition and progress), those who can read the book without realising something of the possibilities of further development must be either very self-complacent or very dull. M. Herubel writes in a masterly way, but with a light touch, of food-fishes, fishing-grounds, oceanic feeding grounds, factors of destruction, fishery laws, re-population, fisheries and science, fishery problems, the social life on the coast, fishing ports, boats and gear, the fishermen, the markets, the outlets, the financial aspect, the humane aspect, the possibilities ahead. But this indication of the contents of the book can give but a faint idea of its interest. The author writes with a full knowledge and with a wide outlook, and scientific as he is, he has not been able to shut out the glamour and sparkle of the sea from his discourse.

J. A. T.

The Animal World.—By F. W. GAMBLE, F.R.S. 255 pages. 36 illustrations. 6¾-in. × 4¼-in.

(Williams & Norgate. Price 1/- net.)

The big text book, it has been said, is out of date before the last sheets have been printed off, and hence the advantage of attending lectures given by a teacher who has to keep abreast of the times. The present volume of the Home University Library certainly fulfils its object and enables one to learn what are the present opinions upon a number of biological matters. Several of Professor Gamble's chapters are particularly interesting, as, for instance, that upon the Colours of Animals. The explanation that the markings which cause an animal to be practically invisible save it from its enemies, is put down as being futile, but the reader must not let the little joke that "protection in animal as in human economics is thought to meet the needs of the time" make him forget that no arguments are brought forward. Those who have only scraps of leisure should carry Professor Gamble's suggestive little book in their pocket and read it at odd moments.

W. M. W.

FIGURE 293.
Helix pisana.

Monograph of the Land and Freshwater Mollusca of the British Isles. By JOHN W. TAYLOR. Part 19. 48 pages. 63 figures. 4 plates. 10½-in. × 6½ in.

(Leeds: Taylor Bros. Price 7/6.)

The latest part of this monograph completes the account of *Helix pisana* which was just begun in Part XVIII and deals also with *Helicigona lapicida*. The plates, which are more numerous than usual, show coloured representations of Hyliana and Zonitoides, which is included to help bring up the arrears as well as variations in colour and size of *Helix pisana* and its distribution. We notice that there is a figure labelled *H. pisana* var. *grasseti* from the Canary Islands; but judging from specimens which the Rev. R. Ashington Bullen recently found in the same locality, and exhibited alive before the Malacological Society, it would appear that this form should be considered a distinct species. As usual, considerable attention is given to the anatomy of the species described as well as to their habits and geological and geographical distribution. By the courtesy of the author we are able to give an example of the black and white drawings of the shell (see Figure 293), as well as to reproduce the picture of *Helix pisana* congregated on its food plant at Tenby. The species is interesting, because in the British Islands its range is restricted to South Wales, South-West England and to Ireland. The species has, however, a wide range in France, Spain, Italy and the North of Africa, and so on, as will be seen from Figure 295, for which we are also indebted to Mr. J. W. Taylor. In conclusion, we would say that the plates are most excellently reproduced, while Mr. Taylor still continues to use every endeavour to deal fully with each species. If we have any criticism it is that the parts do not appear as quickly as we should like, and that descriptions of many so-called varieties might be omitted.

W. M. W.

FIGURE 294.
Helix pisana on its food plant.

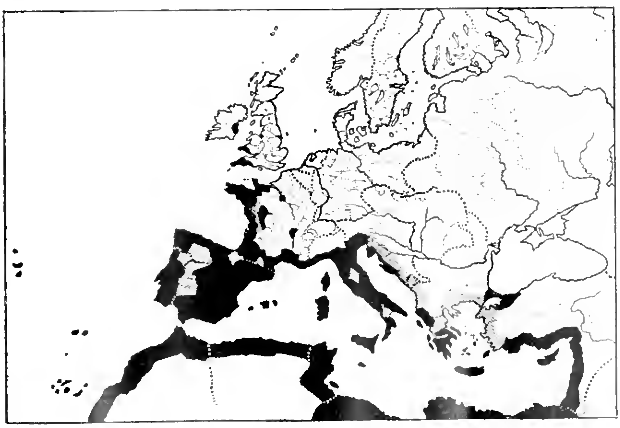


FIGURE 295.
The Geographical distribution of *Helix pisana*.
Black—recorded distribution. Hatching—probable distribution.

LIGHTNING FLASHES.

To the Editors of "KNOWLEDGE."

SIRS,—I send herewith five prints of lightning flashes which I was fortunate enough to secure during a thunderstorm of unusual severity, for this part of the Kingdom, on 9th-10th August last.

FIGURE 296.

Beaded Lightning. Flashes meeting.

In the November issue of "KNOWLEDGE" there was an article and sketches of a storm at Garessio, Italy, which was interesting to read of, and would have been more so had the sketches been photographs, because, in the light of what I have got myself, I do not see how Mr. Parkinson's eye could have taken in and followed the outlines of the *five* streaks, which he shows in his first sketch.

I annex a short description of the storm, with details of the various points noticeable on the photographs, which may be of interest to readers.

The thunderstorm, during which the photographs here reproduced were taken, occurred on the 9th-10th August, 1911, and, in Scotland at any rate, covered a line or belt of about twenty or thirty miles in width. At Dumfries and at Lauder, Berwickshire, it was seen to the eastward; then it seems to have passed right up the east coast of Scotland, being very near at St. Andrew's, Arbroath, Stonehaven, Aberdeen. At Elgin it passed to the eastward, but so far away that little, if any, thunder was heard.

At Stonehaven, Kincardinshire, where the photographs were taken, there were two distinct storms. The first storm commenced about 9 p.m., lasting till about 10.30 p.m., when it passed over and to landward of the town. About 11 p.m. the second came up, lasting till 2 a.m., and passing entirely seaward. From 9 to 10 o'clock no rain fell.

FIGURE 298.

Beaded Lightning.

I had read, some weeks previously, that "in photographing lightning it is necessary beforehand and in daylight to focus the camera as for a distant view, and to mark on the baseboard where the pointer stops." This, fortunately, I had done. The camera was stationary and pointed southward.

FIGURE 297.

Flash from cloud to cloud.

In Figures 296, 297, and 298, the lightning flashes coming from quite different parts of the sky all meet earth (or possibly the sea) in exactly the same spot on the horizon. They might not, however, all do so if seen at right angles to the present view.

Figure 297 is rather a curious flash from cloud to cloud and then to earth.

In Figure 299 the flash ramifies only near to the horizon.

Beaded lightning is seen in Figures 296 and 298.

Figures 296, 297, and 298 were probably taken in this order, though I have no note of it, and Figures 299 and 300 show the storm passing to landward.

Any make of camera would, of course, do for the subject, with the shutter open at its largest aperture, and the same would apply to the plate, as long as it was not too slow. In this case I used Kodoid Cut Films, and developed them in a tank with diluted developer.

H. HARGRAVE COWAN.

ELGIN, SCOTLAND.

FIGURE 299.

Flash ramifying near the horizon.

MISCELLANEOUS OBSERVATIONS, 1912.

To the Editors of "KNOWLEDGE."

SIRS,—I should like to report to you the following miscellaneous astronomical observations made here by means of a three-inch equatorial refractor since the beginning of the year 1912.

1912, March 5th, about $8^h\ 27^m$ C. S. T., a bright, rapidly moving telescopic meteor was observed to traverse the eighty-four-diameter field of my three inch refractor. The meteor did not consist merely of a streak, but resembled more nearly a band of light, especially when it disappeared at the *f.* end of the field of view, where the end of it seemed to grow slightly larger and brighter; it moved from W. to E. and required somewhere in the neighbourhood of one or one and one-half seconds to pass entirely across the eighty-four power field; it was white in color, the light being not intense, but rather soft. This meteor passed only a short distance *s.* of the star cluster M. 38 Aurigae, and in its flight traversed a small group of stars near that object.

The occultation of τ Arietis by the Moon, at $7^h\ 56^m$ C.S.T., on 1912, March 22nd (*Nautical Almanac*, 1912), was witnessed with great interest. Some ten minutes before the phenomenon took place, happening to point the telescope at the Moon I discovered that an occultation of that star was imminent. At the precise moment of ingress the star was instantly cut off from view by the Moon's limb. The whole sight was very pleasing, especially as the star was of magnitude 5·1, and sufficiently bright to remain easily visible in the strongest glare of our satellite; the Moon was then a thin crescent, the occultation occurring on the dark side. A few fainter stars were in the same field. Forbidding local conditions prevented an observation of the egress of τ Arietis from behind the Moon's disc, but instead another little star near by was seen to practically graze the *s.* limb of the Moon, at its closest being only about 20″ *s. p.*, from the limb. This strange phenomenon took place very soon after the predicted occultation.

FIGURE 300.

Storm passing to landward.

Mercury was observed on 1912 March 24th, 27th, and 30th, on every evening being easily perceptible to the unaided eye. It was very unfavourably placed on the 24th, when hardly anything could be made out in it through the telescope, except the colour, which was yellowish, and the general phase, the disc being then discerned to be approximately fifty per cent. illumined. The disc was at all times very small in apparent dimensions, and at no time could a power to exceed eighty-four diameters be employed for studying it, while fifty-six was nearly always preferable. On the 27th it was about 0·4 illuminated, and the apparent diameter, according to *The Nautical Almanac*, was 7″·16. On March 30th, the planet was viewed to much better advantage, as it was "picked up" in strong twilight by the aid of the circles. The crescent form was nicely apparent, it on that date consisting of about 0·35 of the entire disc. The colour of the planet was golden yellow, although this might have been somewhat intensified by the low position of the body. The general color of the illumined portion of the disc was found to shade off gradually back from the terminator, it being lighter in the neighbourhood of that region than elsewhere. This shading was the only topographical feature visible on the planet (through my instrument at least), at the present elongation.

The Sun was observed on 1912, April 3rd, not under very favourable conditions, however, but as far as could be made out with the three-inch telescope, its disc was perfectly free from spots and all other phenomena.

FREDERICK C. LEONARD,
President S.P.A., M.B.A.A.

1,338, Madison Park,
Chicago, Illinois, U.S.A.

HOW TO MAKE STEREOSCOPIC STAR CHARTS.

To the Editors of "Knowledge."

Sirs,—Referring to the article by Mr. A. H. Stuart in June "Knowledge," "How to make Stereoscopic Star Charts," I should be glad to know when the American firm he speaks of placed upon the market a series of Stereoscopic Star Charts. To the best of my belief the first stereoscopic views of the stars were those published by me in my "Road Book to the Stars," February, 1905. These were followed by "Six Stereograms of the Sun and Stars," which I had the honour of exhibiting at the Royal Society's Conversazione, in May, 1905, and followed again in November, 1905, by my "Stereoscopic Star Charts and Spectroscopic Key Maps," which I also exhibited at the rooms of the Royal Society and Royal Astronomical Society. As far as I could then gather no one had ever seen or heard of anything of the kind before. All these were not only printed and published by Messrs. King, Sell & Olding, Ltd., but were also reproduced as very beautiful transparencies and lantern slides by Messrs. Flatters and Garnett, Ltd. As regards this country I own the copyright, but not for America.

In *The English Mechanic*, of October 27th, 1911, Mr. A. H. Stuart, B.Sc., F.R.A.S., published a Stereoscopic Star Chart, which is obviously a copy of my Stereoscopic Star Chart, No. 12, with the small stars blocked out. The stars, as in my chart, are white on a black ground. Presumably, this was taken from the American Stereoscopic Star Charts he refers to, and if so it can easily be understood why "very few of the slides have found their way into England."

The Star Stereogram Mr. Stuart gives in June "Knowledge" is doubtless quite original, but it is calculated to convey the very erroneous idea that the distance of a star can be inferred from its magnitude.

It goes without saying that the correctness of the result in my Stereoscopic Star Charts depends upon the parallaxes upon which they are based being right. I had to do the best I could with the material I could collect. In twenty or thirty years time much more reliable data will be available, and then Stereoscopic Star Charts made by my method will be very valuable. Therefore, it is certainly desirable that others should be able to use it, when there are plenty of good parallaxes and proper motions.

Tenby. T. E. HEATH, F.R.A.S.

SEA SICKNESS.

To the Editors of "Knowledge."

Sirs,—Without entering into a deep treatise on the subject I think I might interest some of your readers by mentioning a factor which is very little thought about, the different rhythm in the waves.

Many people are surprised to find themselves experiencing rough weather without the least sign of sickness, while at times previous they have been dreadfully sick while the weather was nothing like as rough.

Now although that can partly be accounted for by the person being in different states of health, nerves and system generally, nevertheless it is also due to the difference in the rough weather, the different rhythm of the waves. For instance, I have been in the Bay of Biscay in apparently calm sea and have been fearfully sick, because the waves were exceptionally long and not high (a wave is measured from crest to crest)—what we call a swell. And I have been in very rough weather and not sick, because the waves were high but not long, and the motion of the boat, consequently, was a quick rise and fall, quite the reverse to the previous.

That is only a broad example to illustrate my meaning. There is a lot more in it than that. It depends also on the regularity or irregularity of the rise and fall, the height and the speed of the rising and falling, and, the most important thing of all, the length of time after the ship has descended before it starts to rise again, which may be from a fraction of a second to two or three. I have noticed that certain people are specially sensitive to certain conditions of the sea or rhythm.

Birkenhead. C. POTTER.

THE FACE OF THE SKY.

To the Editors of "Knowledge."

Sirs,—I am glad indeed to see that the "Face of the Sky" is now a month in advance of issue.

The want of that was the principal reason why I (in the Colonies) gave up your journal some time ago. If Dr. Crommelin would also use his remaining space to give a summary of the results attained by the observatories of the world, public and private, as regards observation of the planets during, say, the last decade, it would, I think, be a great help to amateurs.

Many amateurs have only more or less ancient history to refer to, which, considering the improved instruments of these days, would perhaps be better consigned, in a great measure, to oblivion.

Vernon, B.C., M. Inst. C.E.
Canada.

QUERIES.

Readers are invited to send in Questions and to answer the Queries which are printed here.

7. INSECT ANATOMY.—I am desirous of studying the Anatomy (Internal) of the Hymenoptera aculeata, and not having time during summer, would like to know of any method of preserving insects for this purpose? H. W.

Luddenden.

8. LIGHTNING.—What is the diameter of the main stem of forked lightning (*a*) between two clouds, (*b*) between cloud and earth? does the diameter vary much? what conditions such variation? W. N. F.

Upper Norwood.

THE "FOURTH DIMENSION." A REPLY.

By JOHN JOHNSTON, M.A., LL.B.

It may be well in the first place to state briefly the argument of Mr. Annison in his article in the June (1911) issue of "Knowledge," and these will be stated in his own words: "The basis of my argument depends on the relation between algebraical equations of two and three variables and geometrical figures of two and three dimensions. It is known, for instance, that the locus of a point moving according to the equation $x^2+y^2=r^2$ is the circumference of a circle, or, in other words, the equation is the 'law of the circle'; and similarly $x^2+y^2+z^2=r^2$ is that of the sphere; but there are an infinite number of equations of this type, each containing one more variable than the preceding one; and arguing by analogy from the first two, the next one, $x^2+y^2+z^2+u^2=r^2$, is the law of a four dimensioned figure . . . . . The fact that we are unable to form any mental image of such figures cannot be ascribed to the equations themselves, which obviously contain no reason either why they should or should not be capable of graphical representation. *Prima facie*, if some equations can be so treated, the remainder should equally admit of such treatment, and our inability to accomplish this must obviously be due to the absence of any mental picture that will satisfy the requirements of the equations."

There is no necessary connection or relationship between the numbers or symbols which we use in arithmetical or algebraical calculations—or any combinations of these—and dimensions of any kind. 1, 2, 3, 10, 10^2, x, x^2, $x^2+y^2=r^2$, $x^2+y^2+z^2=r^2$, and any other numbers or symbols or combinations of these are simply tools which we use in arithmetical or algebraical investigations. These tools were invented long ago; throughout the ages many improvements and additions have been made; and the process is still going on. It is in a totally different sphere of thought and action that we have got our knowledge of dimensions. We, as well as our forefathers in the remote past, have observed that everything has, and must have, length, breadth and thickness. Our observation of this, and our knowledge of this, have nothing to do with calculations of any kind. We might know about dimensions though we could do no calculations, and we might be able to calculate though we knew nothing about dimensions and though there were none.

There are certain kinds of calculations which have to do with dimensions. Carpenters and engineers make calculations in reference to wood and iron, in order to manufacture what is wished. These calculations are based on measurements in the three dimensions which they have made, and the data of these calculations are what they have observed with their eyes. The fact that many of their calculations have to do with the three dimensions is not because there is any necessary relationship between calculations and dimensions, but simply because these calculations are in reference to the length, breadth and thickness of objects existing or to be made. Whether calculations have to do with dimensions or not, the numbers or symbols which we use are nothing more than tools in our hands. If we are raising numbers to powers far above the third in order to calculate compound interest by means of logarithms we do this, not because these high powers have anything in actual existence corresponding to them, but simply because this is a convenient way of making the calculation.

The equations $x^2+y^2=r^2$ and $x^2+y^2+z^2=r^2$ may be simply numerical, or they may be, respectively, the law of the circle and that of the sphere. It is easy with a pen to insert u^2 and any number of additional symbols which we may wish. But we have not a particle of evidence that the equation with u^2 is other than simply numerical—that it has anything corresponding to it in real existence. It is not an argument by analogy that the equation with u^2 is the law of something in four dimensions; it is a pure assumption. Our knowledge that $x^2+y^2=r^2$ is the law of the circle and $x^2+y^2+z^2=r^2$ is that of the sphere is got by experience of the circle and the sphere, and by that alone. And we have no experience of anything in four dimensions. A man in the presence of three mountains may make sketches of them on paper. He will probably be able to make a fourth sketch somewhat similar to the others. But it would not do for him to conclude that because he made it there must be a fourth mountain. A boy may be making calculations up to the number three and may be illustrating these calculations by making three crosses on paper and by moving about three apples on a table. He will no doubt be able to make a few more crosses on the paper, but it would not do for him to conclude, "arguing by analogy," that there must be more apples on the table, and that his inability to see them must be due to some physical or mental defect. The apples have no necessary relationship with the crosses nor the crosses with the apples; nor have dimensions any necessary relationship with equations or equations with dimensions.

A correspondent in the August (1911) issue of "Knowledge" says that he believes he has been able to demonstrate, "assuming the truth . . . . of the principle of the continuity of mathematical law, that the fourth and higher dimensions do actually exist; the existence of a third dimension implying that of a fourth, and so on, to infinity." It is not a case of mathematical law at all. We have no reason to believe that, because certain mathematical expressions correspond to existing things, and because we can arbitrarily add to these expressions, the new ones must have something in existence corresponding to them. Mathematical law is consistent and continuous within its own sphere—that of calculation—but it will never enable us to discover what is or is not in actual existence. In so far as our calculations can give us knowledge as to things existing, this knowledge must be involved in the data of these calculations, and these data must be got by experience. A third dimension does not imply a fourth any more than a third apple implies a fourth on the boy's table.

Mr. Hinton—referred to by another correspondent—bases his arguments on descriptions of objects moving about or turning round. It is surely self-evident that whatever objects we take, and whatever motion we give them—backwards, forwards, rotary, or any other motion, or any combination of motions—the appearances which these moving objects present to us can give no proof, or no evidence, of the existence of another dimension. This point need not be laboured; it can be left to the readers of "Knowledge."

It may be mentioned incidentally that if Mr. Annison did not confine himself to the circle and the sphere, he would not get his basis. $x^2+y^2=r^2$ may represent a locus in three dimensions as well as one in two. It may represent a right cylinder. Also $x^2=r^2$ in three dimensions represents two planes parallel to each other and each distant r from origin.

Of course, there may be a fourth dimension and many more dimensions. There may be invisible apples—of extreme tenuity—on our tables, invisible trees in our gardens, invisible cats at our firesides and invisible planets in our solar system. All that we can say is that we have no evidence of the existence of these apples or these trees or these cats or these planets or of the fourth dimension.

There is much about us that is beyond our grasp. We cannot conceive of space as being either limited or unlimited. We cannot think of a boundary beyond which space is no more. Nor can we think of space as going on—far beyond the furthest star, if there is one—for ever. Our belief in cause and effect—that everything occurring or existing must have a cause—is inconsistent with our belief in the existence of the world. We are on safe ground only when we keep within the limits of experience, or of what follows closely from the known facts of experience. If we reason too far from these facts—though our reasonings may be quite logical—we land ourselves in inconsistencies. It is worse if we leave our reason and follow our imagination instead.

NOTE ON A PARIS PHOTOGRAPH OF THE ECLIPSE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

FIGURE 301 was obtained at the Paris Observatory, by MM. Demetresco and Carrus, with a telescope of ten metres focus placed before the siderostat. The Observatory was some twelve-and-a-half miles distant from the central line, and consequently a crescent of sunlight about 8" in width remained uneclipsed. This appears as a confused glare in the picture in consequence of over-exposure. The thin white crescent on the other side of the moon's disc belongs to the chromosphere, not to the body of the sun. Some prominences are seen rising out of it, a large one near the bright solar crescent being especially noteworthy. The irregularities of the moon's limb break the chromospheric ring into beads in a few places. These are analogous to Baily's Beads. The part of the moon most distant from the solar crescent is seen outlined against a faint light, which is, I think the inner corona. The Paris observers are to be congratulated on obtaining such an interesting photograph.

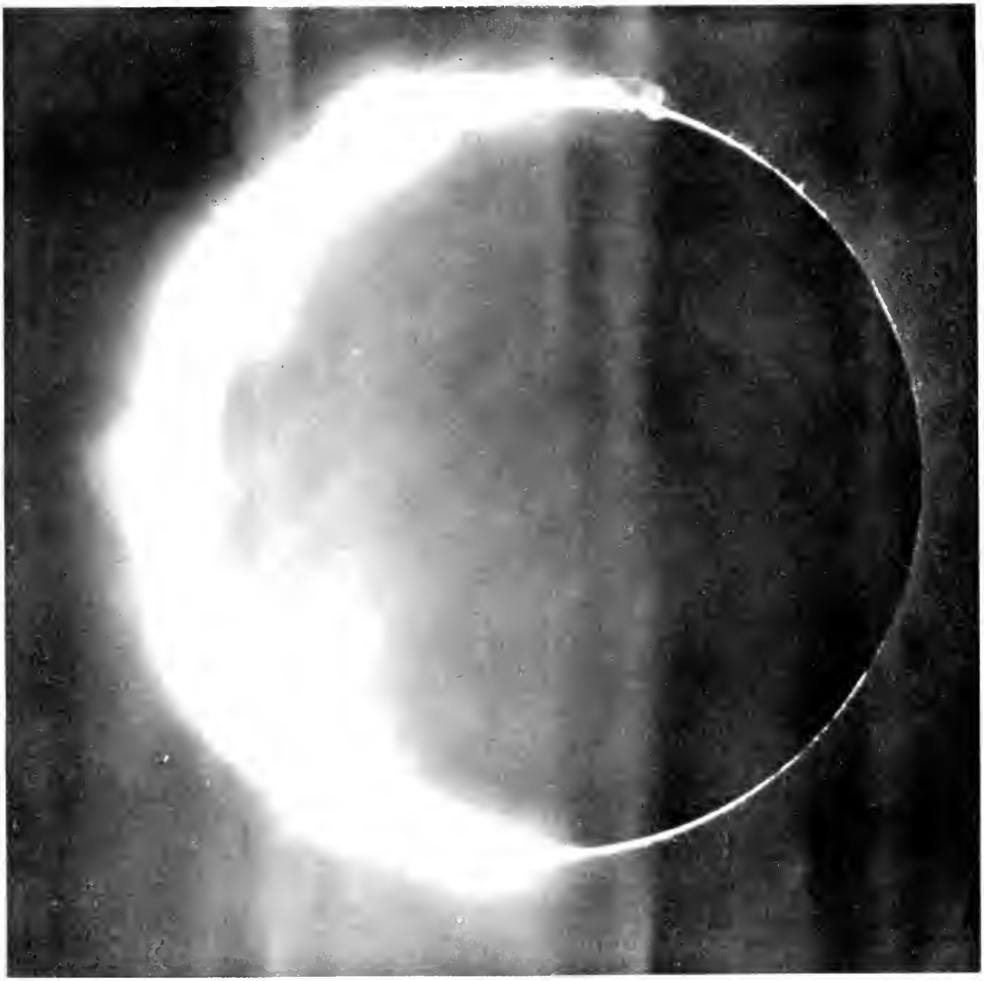


FIGURE 301. The Eclipse of the Sun.

NOTES.

ASTRONOMY

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

PROFESSOR TURNER'S SUGGESTED EXPLANATION OF THE TWO STAR-DRIFTS. Professor Turner contributed papers to the March and April numbers of *The Monthly Notices*, making a new suggestion to explain the apparent division of the stellar motions into two drifts. It has generally been assumed that a drift converging to or diverging from an apex (like a meteor radiant) indicates a series of motions along parallel paths. But Professor Turner reminds us that the same result would follow from an actual convergence of motion to a point and divergence from it. He suggests that the stars may be moving in very elongated orbits about the centre of the sidereal system, so that at any moment they may be divided into those moving inwards and those moving outwards. He gives, as an analogy, the system of comets moving round the sun; at any instant practically all of them are moving either nearly to the sun or nearly from it.

Sir John Herschel, in the "Outlines of Astronomy," briefly discussed the case of motion in spherical star clusters. Assuming the density of distribution as uniform, it is easy to see that the attraction towards the centre of the cluster is as the direct distance, and hence the stars would all describe ellipses in the same time about the centre. In actual clusters the density is not uniform; Mr. Plummer suggests a law of density found by Schuster for gases, viz., $(c^2+r^2)^{-5/2}$, where r is the distance from the centre and c is a constant. The form of the actual sidereal system appears to be ellipsoidal, and the density not uniform, so that the orbits would not be strictly ellipses, nor would the periods be the same for all stars. Professor Turner fixes the vertex at R.A. 94°, N. Dec. 12° as the probable centre of the system, and shows that this agrees very well with the centre (R.A. 113°, N. Dec. 22°) found by Mr. Lewis from the distribution of apparently fixed and moving binary systems. He suggests that our Sun was near the centre a million years ago, and that the period of a complete oscillation is about four hundred million years, the semi-axis major of the orbit is about six hundred light years. The crowding indicated near the centre is such that the distance between neighbouring stars there is half that from the Sun to Alpha Centauri.

While there is much that is highly speculative in these papers, they are interesting as an attempt to coordinate the results of a great many different series of observations, and as giving a readily intelligible meaning to the two stellar drifts.

Mr. Eddington has also a paper on star distribution in the March number of *Monthly Notices*. He gives a diagram of velocity distribution that brings out the two drifts very forcibly, and suggests a third drift. Deducing the distances of stars from their proper motions, he gives the following table of the average parallaxes of the stars in Boss's Catalogue (that is, roughly, the stars visible to the naked eye). Out of one hundred naked eye stars he finds that 1·0 has a parallax between ″·10 and ″·08, 1·5 between ″·08 and ″·06, 2·9 between ″·06 and ″·04, 9·5 between ″·04 and ″·02, 8·6 between ″·02 and ″·015, 17·5 between ″·015 and ″·010, 11·7 between ″·010 and ″·008, 14·9 between ″·008 and ″·006, 16·6 between ″·006 and ″·004, 10·0 between ″·004 and ″·002, 2·4 between ″·002 and ″·001. Of course, the falling off at the end is due to the fact that at great distances stars must be of extraordinary lustre to be visible to the naked-eye, so that only a few of the naked eye stars lie in these distant regions.

PLANET MT. In addition to the Greenwich observations of this body on October 11th last, traces of it have been found on a plate taken at Heidelberg on October 17th. The following elements are rough, but give a general idea of the character of the orbit.

Perihelion Passage, 1911, August 31st.

Node	...	...	...	...	185° 27′
ω ...	...	...	...	...	151 27
i ...	...	...	...	...	8 32
Period	...	...	...	...	2·6 years
Eccentricity	...	...	...	...	0·40

Perihelion Distance, 1·15, practically the same as that of Eros. The eccentricity is, however, much greater, and is almost the greatest known for planetary orbits.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

POTASSIUM AND PHOTOSYNTHESIS.—At the conclusion of a paper on the photochemical synthesis of carbohydrates from carbon dioxide and hydrogen, Stoklasa and Zdobnicky (*Biochem. Zeitschr.*, Band 30, 1911) state that their experiments have given the following somewhat remarkable results. Neither formaldehyde nor carbohydrates are formed by action of ultra-violet light on water and carbon dioxide in absence of potash; but if potash be present, formaldehyde is produced, without formation of carbohydrates. By the action of ultra-violet rays on carbon dioxide and hydrogen, in presence of potash, neither formaldehyde nor carbohydrates are formed unless the hydrogen is in the nascent condition—in which case sugars are produced; without the action of these rays, carbon dioxide and nascent hydrogen produce, in presence of potash, formic acid but not carbohydrates. This is the first case observed of the synthesis of sugar from potassium bicarbonate and nascent hydrogen. The writers suggest that in the living green cells of plants the water and carbon dioxide, under the action of potassium bicarbonate, produce formaldehyde, which is then condensed into sugar in the presence of potash. The interest of these observations lies in the importance attached to potassium as an essential factor in the synthesis of carbohydrates from water and carbon dioxide in the living green cell.

LIFE CYCLE OF RED ALGAE.—The cytological observations of Yamanouchi on *Polysiphonia*, Lewis on *Griffithsia*, and Svedelius on *Delesseria*, suggest that not only in these genera but in all Red Algae in which the tetraspores and sexual organs are regularly borne in separate plants, there is an alternation of generations, the germinating carpospores giving rise to asexual plants, and the germinating tetraspores to sexual plants. Lewis has now (*Bot. Gaz.*, LIII.) succeeded in testing this matter by actual cultivation of the sporelings of a number of Red Algae, though it has proved a difficult task to raise the young plants. The physiological tolerance of these Red Alga sporelings is very small; temperature, light, and other factors may vary only within very narrow limits. The cultures had to be transferred to the open water, and many precautions taken to ensure their further growth.

Successful cultures showed that in *Polysiphonia* the carpospores produced only tetrasporic plants; while from the tetraspores of *Griffithsia* and *Dasya* only sexual plants were obtained. Tetraspores from a single individual produced male and female plants in approximately equal numbers in *Griffithsia*; the preponderance of males found in the cultures of *Dasya* is explained by the early development of the sexual organs on these as compared with the females. This segregation of the sexes in equal numbers agrees with what has been found in dioecious liverworts and other plants. Lewis obtained no evidence whatever that the double number of chromosomes in the carpospores imparts greater vigour of growth as compared with the single number in the tetraspores.

BIOLOGY OF SALT-MARSH PLANTS.—Two interesting papers have recently appeared which deal with the physiology of certain halophytic plants growing in salt marshes. Miss Delf (*Ann. Bot.*, XXV), describes experiments in which the loss of water by transpiration is estimated by measuring the total transpiring surface and observing loss of weight during withering. The author concludes that typical halophytes like *Salicornia* and *Suaeda* have a high rate of transpiration which is comparable with, or may be even greater than, that of a typical mesophyte like the broad bean. Statistics are given of the distribution and number of stomata per square centimetre in various salt-marsh plants. The stomata of *Salicornia* and *Aster tripolium* are not sunken nor protected by cuticle to any great extent, but rather resemble those of a typical mesophyte in being superficially placed, capable of opening and closing, and sensitive to light and to changes in humidity of the air. The stomata of *Salicornia* seem to lose power of movement after the flowering period, and then remain permanently closed; these of *Aster tripolium* were seen to open in air nearly saturated with water vapour, but closed in air with seventy-five per cent. humidity; those of *Suaeda* and *Atriplex* were never seen open at all.

Miss Halket (*New Phytologist*, X) describes experiments made with the object of ascertaining whether or not salt-marsh plants with high osmotic pressures can obtain water from atmospheric moisture and from sea-water. It was found that these plants can absorb water even when immersed in salt solution, whereas non-halophytic plants like the primrose decrease in weight when immersed in salt solution, though they increase when immersed in distilled water. The root-system of these salt-marsh plants is small in proportion to their size, hence the amount of water absorbed by the root is probably relatively small; the water obtained from atmospheric moisture through absorption by the aerial parts may compensate the plant for this smallness of root absorption.

BIOLOGY OF *SELAGINELLA*.—In a previous note in these columns ("KNOWLEDGE," 1911, page 350), some of the results of recent work on the reproduction of *Selaginella* was summarised. Seyd (*Inaug.-Diss.*, University of Jena) has published an interesting account of his observations on the biology of the vegetative organs of this well-known type. He has made experiments on the taking-up of water by the leaves, which had already been noted by previous writers but not fully investigated by them. He believes the ligule of the leaf is largely concerned in this absorption of water, and has made some ingenious and interesting experiments on this point. He placed shoots of *Selaginella* in solutions of various chemical substances and dyes, and the results in every case showed that the absorption occurred at the ligules of the leaves, and diffuses thence into the vascular bundles. Previous writers had suggested that the chief or sole function of the characteristic ligule of this genus is to protect the growing-point of the shoot and the young leaves. Seyd also experimented with the rhizophore and found that this organ absorbs water and salts only when it has reached the soil and produced root-hairs.

NAKED-EYE ANATOMY OF PLANTS.—Teachers and students of Botany are so accustomed to rely upon the compound microscope that they probably do not realise what a large amount of plant structure can be made out with the unaided eye or with a low-power pocket-lens. A useful and interesting paper by Arcichovskij (*Bull. jard. imp. bot. St. Petersbourg*, XII, 1)—unfortunately in Russian, but with a summary in German—contains an account of various materials, some well-known and others new, suitable for this purpose. The stems of cucumber and vegetable marrow, as is known to most teachers, have unusually large and distinct vessels in the wood, as well as large cells, and form an unrivalled introduction to the microscopic study of the tissues of plants. Almost equally suitable are the stems of balsam and begonia, while large cells (sometimes over a millimetre long) are to be seen in the flesh of the arbutus fruit, the epidermis of unripe tomatoes, and the epidermis of the leaves in various plants—*e.g.*, *Tradescantia*, begonia seedlings. Very large cells also occur in the leaves of various succulent plants, such as *Echeveria*, *Mesembryanthemum*, *Kleinia*, *Crassula*, *Aloe*. The nucleus can be plainly seen with a lens magnifying ten diameters, in the flesh of the arbutus fruit, and the streaming of the protoplasm in the enormously elongated cells of the stonewort *Nitella* is equally easy to see with a low-power lens or even with the unaided eye. The same simple method suffices for making out the distribution of the stomata in the leaves of the spruce fir and of various succulents—*Agave*, *Kleinia*, many cacti, and so on.

CHEMISTRY.

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

DEVITRIFICATION OF SILICA GLASS.—Sir William Crookes describes in *The Proceedings of the Royal Society* (1912, LXXXVI, A, 406) a curious experiment upon a tube of silica glass. When this was exhausted and heated for several hours at a temperature of 1300° C. its structure was completely altered, and it had become devitrified to such a degree that it had become permeated to the extent of about eight per cent. with air. On repeating the exhaustion and heating the infiltration of air was found to have attained 46·6 per cent. of the capacity of the material, while in the case of a similar tube of ordinary glass only a minute bubble of air had entered.

Examined under the microscope the devitrified silica showed that the surface was broken up into cells, some of which were hexagonal. The effect closely resembled that produced by evaporating a solution of radium bromide in a silica dish, though when no heat is applied radium salts can be kept for many years in either silica or glass vessels. The devitrification of silica is thus caused either by exposure to a very high temperature or by the action of salts of radium at the temperature of boiling water.

ALCOHOL AND YEAST FROM BANANA MEAL.—A cheap process of manufacturing alcohol is described by Herr C. Nagel (*Zeit. Spiritusind.*, 1912, XXXV, 185), banana meal being used as the original material. The fruit, which must be unripe, since otherwise it forms a sticky mass when dry, is peeled, dried and ground to a meal. The meal is mixed with water and a little malt extract, and mashed at a temperature of 140° to 160° F. so as to effect the saccharification of the starch. This is brought about by the action of a diastase which is present in the banana, and to which the change of starch into sugar during the ripening of the fruit is due.

After completion of the mashing process the wash is cooled and set with a suitable yeast, which ferments the sugar into alcohol, a yield of 42 to 47·8 litres being obtained from one hundred kilogrammes of the meal, the cost of which is about sixty shillings.

The addition of the malt extract to the mash was found necessary for obtaining a good yield of alcohol, the quantities being much lower when the malt was omitted.

A wash obtained from a mixture of banana meal and malt, in the proportions of two to one, is an excellent medium for the cultivation of yeast of excellent quality, the yield amounting to about a fifth of the weight of the original materials.

ALLOYS OF RADIUM.—Messrs. de Mare and Jacobs describe the production and properties of an alloy of radium and silver in a communication to a Belgian journal, which is abstracted in the *Chem. Zentralbl.* (1912, I, 1430). The new alloy, which was obtained by reducing a mixture of silver chloride and radium sulphate by means of calcium carbonate and charcoal in a gas furnace, was a yellowish radio-active substance, which was sufficiently tenacious to be drawn out into a thin wire.

A deposit, possibly of the nature of an alloy, was also found to be formed upon the cathode, when a solution of radium acetate was electrolysed with platinum electrodes. The deposit was a brown substance, which was very radio-active.

In connection with these investigations it was discovered that the light rays emitted by [illegible] of radium could be transmitted through quartz plates of a certain thickness, while the α, β and γ rays were absorbed.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

THE MINERALS OF TONOPAH, NEVADA.—A paper with this title is issued as Number 1 of the seventh volume of the Bulletin of the Department of Geology, University of California, and is written by A. S. Eakle. The Tonopah minerals occur in the great silver deposits of that district, and were previously mentioned by Spurr in his monograph on the Tonopah mining district. The typical ore consists of a gangue of massive white quartz and felspar, with blotches and bands of granular, black, silver minerals, pyrites, chalcopyrite, galena, blende, and occasionally flakes of free gold. It is deposited in an igneous rock, first designated by Spurr as "earlier andesite," but now recognised as trachyte. The Tonopah ore occurs in an arid region, in which simple hydration is not the dominant mode of weathering. What surface waters there are work downwards over the veins, strongly charged with soluble material from the overlying and adjacent rocks, and complex oxidations with unusual mineral precipitations result. The most important minerals in the zone of oxidation are the three silver haloids, cerargyrite, embolite and iodyrite, but numerous other rare minerals are obtained.

THE VOLCANOES OF MADAGASCAR.—Professor A. Lacroix, now the only one remaining of the brilliant trio of French petrologists, the other two members of which were Michel-Lévy and Fouqué, writes on the volcanoes of the French colonies in the Indian Ocean, especially those of Madagascar, in an address to the Congrès des Sociétés Savantes à Paris (April, 1912). Madagascar contains many volcanoes, both ancient and comparatively recent. The island is built up of a mountainous backbone consisting of crystalline schists and granite, rising abruptly out of a sandy plain on the east coast, and from under extensive stratified formations on the west.

Volcanic rocks abound in the midst of the sedimentary series. The principal centre is at Ankaratra near the centre of the island. The lavas of Ankaratra can be followed without interruption for over one hundred kilometres from North to South, and fifty kilometres from East to West. The total area covered by the volcanic rocks is certainly not less than four thousand square kilometres. It is believed that these belong to the Tertiary period, but in the absence of intercalated sediments and fossils it is impossible to date them exactly. Scoria cones and craters, still intact, show that the volcanic activity persisted until a very late period.

Vulcanism began in the Ankaratra massif by a deluge of black lavas—felspathic basalts—which, to judge by the extent of their flows, must have been emitted in a state of great liquidity. These lavas were erupted from a long series of volcanoes aligned in a N.N.E.–S.S.W. direction. After this outburst, the centres of activity became more localised and differentiated. In the centre and south of the massif, mica-trachytes were erupted, and in the south-west, alkali trachytes and phonolites. After this extravasation of pale-coloured rocks a series of black nephelinites were erupted, descending in all directions from the high summits of the chain. The phonolitic rocks of the south-west are remarkable for the fine dome topography they present. The same topography is found in a second, but smaller, massif, that of Itasy, to the north-east of Ankaratra. The phonolite domes or puys are here accompanied by very recent cones of basaltic scoria, and rest upon an undulating surface of ancient rocks, thus reproducing the essential features of the chain of puys in Auvergne. "Imagine," says Professor Lacroix, "the latter transported to the side of one of the Italian lakes, with its blue waters and azure sky, and you will have some idea of the marvellous panorama furnished by the Itasy region. If, however, the local colour is to be preserved, it would be necessary to people the lake with enormous crocodiles!"

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended May 18th, as set out in the Weekly Weather Report issued by the Meteorological Office, was changeable. Rain was reported in all districts, thunderstorms were experienced on four days, and a sharp line squall passed over the Midlands on the 16th.

Temperature was above the average in all districts except Scotland, N. and W., and in Ireland. The highest readings were 74° in Jersey on the 12th, 73° at Tottenham and Camden Square on the 14th, and 72° at Greenwich and Southampton on the 12th. The lowest of the minima were 27° at Balmoral on the 13th, and 30° at Colmonell and Newton Rigg. Temperatures at or below the freezing point were reported from six districts. In the English Channel the lowest reading was 45°. On the ground the temperature fell to 23° at Balmoral and Newton Rigg and to 24° at Crathes. The soil temperature both at one foot and at four feet depths remained above the average of past years.

Rainfall was in excess in Scotland, N. and E., and in England N.E., S.E. and the Midland Counties, but was in defect elsewhere. At a few places in Scotland and at Buxton the total precipitation for the week exceeded one inch, and at Wick it exceeded two inches, but generally the amounts were light. At Holyhead no rain was measured. Sunshine was above the average in most districts, markedly so in Scotland, E. and W., and in England, N.W. The sunniest district was Scotland, W. with a daily average of 9·4 hours (59%). The least sunny districts were the Midland Counties and England S.W., with an average of 5·9 hours a day (38%). The sunniest station was Douglas, Isle of Man, where the amounts registered equalled a daily average of 11·5 hours or 72 per cent. of its possible duration.

The mean temperature of the sea water round the coasts varied from 46°·0 at Berwick to 55°·9 at Eastbourne.

The weather of the week ended May 25th was generally cool, cloudy and unsettled. About the middle of the week thunderstorms were reported in the midland and eastern counties.

The mean temperature was above the average in England, E. and the English Channel, but below it elsewhere. The greatest deficiency was in Scotland, E., where the average value was only 46°·3 as compared with the average over twenty five years of 49°·6. The maxima were low. In only four cases were temperatures of 70° or upwards reported, namely 72° at Greenwich, and 71° at Camden Square and in Jersey and 70° at Raunds. In most cases these occurred on the 19th. At all other stations the maximum for the week was less than 70°, and in Scotland, W., and England, N.W., the highest readings did not exceed 64°. The lowest readings for the week were 28° at Balmoral and 29° at West Linton and Markree Castle. In the English Channel the minimum did not fall below 46°. On the grass low readings were again reported, down to 22° at West Linton, and 24° at Crathes and Newton Rigg.

The temperature of the ground at one foot depth was generally below the average but at four feet depth it was still in excess. Rainfall varied greatly. In England, N.E. and the Midland Counties it was very heavy, at some stations four times as much as usual. In Scotland, on the other hand, the week was dry and in Scotland, N. the total was less than a quarter of the average amount. At Spurn Head, which is usually one of the stations with least rainfall, the total for this week was 2·07 inches as compared with an average of 0·36 inches.

Sunshine was in defect in all districts except Scotland, N., and the English Channel. The last-named district had the largest daily average amount, 9·6 hours (62%), but Scotland, N. reported 8·4 hours (48%), while the Midland Counties had only 4·2 hours (26%). The station reporting the greatest duration of sunshine was Deerness, Orkney, 11·2 hours (65%). At Westminster the average for the week was 4·9 hours (31%).

The mean sea temperature ranged from 46°·8 at Berwick to 56°·6 at Margate.

The week ended June 1st was fine and dry at first, but the weather became showery and thunderstorms occurred. Solar haloes were observed on the 26th. Temperature was below the normal generally, but in Scotland, W., and the English Channel it was slightly in excess. The highest readings reported were 77° at Greenwich and Camden Square on the 30th, with 74° at Norwich, and 73° at Raunds. The lowest of the minima were 29° at Llangammarch Wells on the 26th, 30° at Balmoral on the 27th, 31° at West Linton, and 32° at Colmonell on the 26th. At no other station besides the four just named was frost recorded in the air at four feet above ground. On the grass the lowest readings were 24° at Greenwich and West Linton, and 25° at Crathes. The temperature of the soil at one foot depth was below the average in most places, while at four feet depth it was still in excess.

Rainfall was more than usual in England, N.E., the Midlands and the English Channel. In England, S.E., it was just normal, but in all other districts it was in defect. In Scotland, E., the total was less than one quarter of the usual amount, and in Scotland, N., just over one-third. The number of rain-days over the whole kingdom agreed with the average.

Sunshine was above the average in England, S.E., N.W., S.W., Ireland, S., and the English Channel; it was equal to the average in Ireland, N., but below the average elsewhere. In England, N.E., the mean daily amount was only 3·8 hours (23%). In the English Channel it was 10·4 hours (66%). Of individual stations Baltasound, Shetland, reported a daily average of 1·4 hours (8%) while Weymouth had 11·6 hours (73%). At Westminster the average was 7·2 hours (45%), while Hampstead had 8·1 hours (51%). The temperature of the sea water ranged from 46° at Lamlash to 59° at Eastbourne.

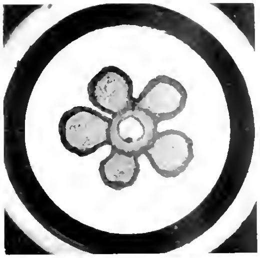
The weather of the week ended June 8th was very unsettled with much rain and many thunderstorms. Temperature was low for the time of year, every district reporting values below the normal. The maxima were unusually low. At only four stations were readings of 70° or upwards recorded, namely at Camden Square and Plymouth 71°, and at Greenwich and Tottenham 70°; these all occurred on the 6th. The lowest readings, however, were not as low as in the previous week, the minimum being 32° at Balmoral. The next lowest was 33° at Killarney. In Scotland, N. and E., with the exceptions of 32° at Balmoral already mentioned and 39° at Strathpeffer the minimum nowhere fell below 40°. At Leith and at Guernsey the lowest readings were the same, 48°. On the grass the lowest readings observed were 29° at Balmoral and 31° at Greenwich. The temperature of the soil, both at one foot and at four feet depths was below the average very generally.

Rainfall was slightly below the average in Scotland N., but was in excess in all other districts, and very greatly so in some. Thus in the English Channel the total for the week was 2·15 inches as compared with an average of 0·44 inches, or almost five times as much as usual. In Jersey it rained each day throughout the week, the total collected being 2·85 inches. At Harrogate the total was 3·20 inches, though at that station there were two days on which no rain fell.

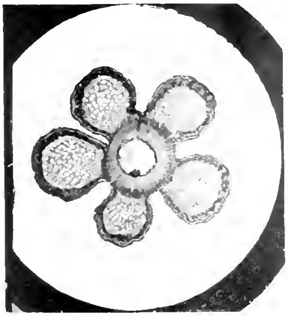
Sunshine was in defect in all districts, and at each individual station except Valencia and Markree Castle. Valencia was the sunniest station with a daily average of 7·6 hours (47%). At Glasgow the daily mean was only 0·9 hours (5%). In Westminster the daily average was 5·2 hours (32%).

The temperature of the sea water ranged from 47° at Berwick to 62° at Margate.

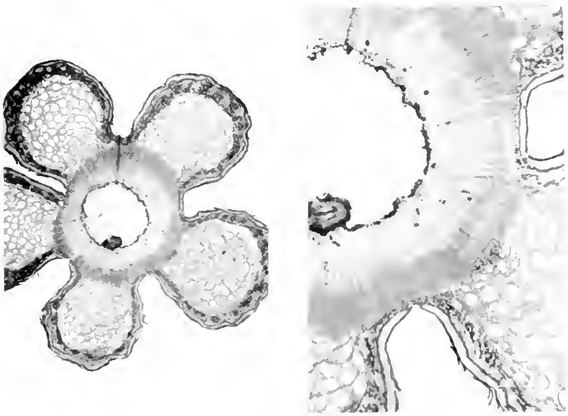
THE SPRING.—The period of thirteen weeks, March 3rd to June 1st, which is regarded from a meteorological point of view as Spring, was this year on the whole warm and dry, with an average amount of sunshine. In England, S.E., of the thirteen weeks seven were unusually warm, one unusually cold and five not far from average; two weeks were very wet, five weeks very dry and in six weeks the rainfall was about normal; while six weeks were unusually sunny, three weeks unusually dull, and during four weeks the sunshine was moderate.



A



B



C D

FIGURE 302. Trans-section of a Brazilian liana.

MICROSCOPY.

By F.R.M.S.

LOW POWER PHOTO-MICROGRAPHY. EQUIVALENT EXPOSURES.—One of the great troubles of the inexperienced worker in this fascinating branch of work is the problem of *equivalent exposures* with different lenses and stops, and so on. But I think the matter may be put in such a simple form that not only can it be easily understood, but what is perhaps of still greater practical importance—easily remembered and carried out in practice.

First, let us take the case of a fixed camera, length say twelve inches (objective to plate), and the same numerical stop number, e.g., *f*.11.

I have four lenses whose focal lengths are four, three, two and four-fifth inches respectively. What are the equivalent exposures for the same object, lighting, camera length and stop?

Theoretically it may not be quite correct to say that exposure varies directly as area magnification or the square of linear magnification, but in practice this rule works quite well, [illegible] be [illegible] of the [illegible] here given. Photo[illegible] about [illegible] having [illegible] linear size of the [illegible] to the focal length of the lens. But this [illegible] measure [illegible] corresponding dimensions of A and B [illegible] with the four and three inch lenses respectively [illegible] that the longer focal length has given us the [illegible] power. Moreover, their linear dimensions are not in the proportion of four to three. The fact is, firstly, that [illegible] conditions of everyday photography are changed, and we are now using the longer conjugate distance. And this does not vary simply in proportion to focal length. Nevertheless, the [illegible] is simplicity itself. If we call c the [illegible] conjugate, f the focal length of the lens and *m* the magnification, the formula is $c = (1 + m)f$.

To apply this we subtract *f* from c and then divide what is left over by f. For example: with twelve-inch camera and four-inch lens. Subtracting four from twelve gives eight, and dividing this by four gives us two magnifications. In the case of the three-inch lens, taking three from twelve leaves nine, which divided by three gives three magnifications. Now area varies as the square of linear size and exposure varies as area size.

Putting matters in tabular form we see the whole thing at a glance.

	A.	B.	C.	D.
Focal length of lens	4"	3"	2"	1"
Magnification (linear)	2	3	5	14
Area	4	9	25	196
Exposure	4"	9"	25"	3¼'

Examples A, B, C, and D (see Figure 302) were made with quarter plates cut in half, exposed as in the above table, developed, and printed together.

Now comes the everyday question of equivalent exposures with different lenses, camera lengths, and stops, but the same object and lighting conditions. For example: (i) Camera length, fifteen inches; lens three-inch focus; stop, *f*.11. (ii) Camera length, sixteen inches; lens, two-inch focus; stop, *f*.16.

Ascertaining magnification in the way just mentioned, we get four and seven respectively. Area ratios are, therefore, as sixteen to forty-nine. With the same *f* value of stop in both cases, this would also be the exposure ratio. But we propose using *f*.11 in the first case, and *f*.16 in the second, so our exposure ratio becomes sixteen to twice forty-nine, *i.e.*, ninety-eight, or, say, one to six nearly.

By putting matters in tabular form, the arithmetic steps can be seen at a glance:

Camera length	15 in. ...	16 in.
Focal length of lens	3 in. ...	2 in.
Magnification (linear)	4 ...	7
Relative areas	16 ...	49
Relative exposure with *f*. 11 in both cases	16 ...	49
Exposures with different stops ...	16 (*f*. 11) ...	98 (*f*. 16)
Approximate ratio	1 ...	6

The object is a Brazilian liana, trans-section. Plates — Imperial N.F. Daylight reflected by substage mirror.

It is important to note that in the first table the exposures, measured in seconds, happened to coincide with the exposure ratio numbers. But this is merely a coincidence in this special case, where the nature of the subject and lighting conditions suggested ten seconds for the first, and so the other exposure times necessarily agreed with the ratio numbers. [illegible] to the second table we see the ratio numbers are roughly one and six, but whether the exposures be one and six seconds, or one and six minutes, and so on, will depend on the nature of the object that is being dealt with, speed of plate and lighting. I want to emphasize the point that the above considerations only give us ***relative*** and not actual times.

The practical application of the matter is this. By a few trials one can ascertain the exposure of, say, object P, under a given set of conditions, as in example (i) in the second table; but we want to deal with object Q under conditions (ii). We have ascertained for the *same* object that the exposure ratios are as one to six. If now we view the two different objects under the microscope, or as a ground-glass image under precisely identical conditions, we can make a reasonably good guess as to their required exposures. Let us say, by way of example, that P seems to require about one and a half times that for Q, under precisely identical conditions, *i.e.*, P to Q as one and a half to one, or three to two. But the table for different conditions (i) to (ii) says one to six. Therefore, P under conditions (i), and Q under conditions (ii) combines these ratios; which we get by multiplying three and one and then two and six, or three to twelve, or one to four. Knowing the appropriate exposure of one of our objects the other is at once estimated.

F. C. LAMBERT.

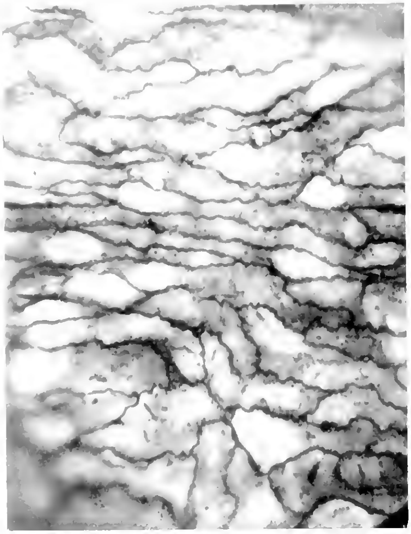


FIGURE 303. A Mesentery of the Frog.

Note the deeply-stained intercellular substance between the cells of the pavement epithelium covering one surface of the mesentery.

(Photographed under Bausch and Lomb ⅔ objective, No. 1 ordinary ocular. Bellows, length 7 inches).

AN ALTERNATIVE SILVER METHOD FOR DEMONSTRATING THE CEMENT SUBSTANCE IN PAVEMENT EPITHELIUM. — The usual method for staining the cement substance of epithelium consists in soaking the tissue in silver nitrate and exposing to sunlight until the tissue turns brown.

This method has a drawback in that it is dependent upon a fine day for a successful result. The method given below overcomes this disadvantage by doing without the exposure to light altogether.

A frog's mesentery may be taken as a typical example upon which to work. The method is as follows:—

1. Pin out the mesentery, with its encircling loop of intestine, upon a cork; then wash it once in distilled water.
2. Place the cork with the tissue undermost, in a half to one per cent. solution of silver nitrate for five minutes.
3. Wash in distilled water to rid the tissue of excess of nitrate.
4. Prepare a hydrokinone developer of the usual photographic strength, and dilute it with five times its bulk of water. In this immerse the tissue and cork, taking care to keep the tissue evenly covered with the fluid all the time. When the tissue has changed from white to a light grey, or light brown, remove it and wash very thoroughly to clear it of developer.
5. Next place the tissue in a five per cent. solution of hyposulphite of soda for fifteen to twenty minutes. Before starting Part 5 the tissue may be removed from the cork.
6. Wash thoroughly; place in a dish of water and cut away the intestine which encircles the mesentery. Dehydrate the latter in alcohol, clear in clove oil, and mount in Canada balsam.

It will be noticed that the method is divided into six parts. I find that the chief factor in obtaining a good result by this method consists in paying careful attention to Part 4. It is essential that the tissue should not be over-developed.

No light is necessary; on the other hand, a dark room is not needed, for the whole operation can be carried out on the laboratory table, either in the daylight or by artificial light.

Tissues prepared in this way are stained in black and white, thus providing a good contrast.

The accompanying photograph gives a good idea of the result obtained by this method.

C. F. JENKINS.
Physiological Laboratory, University College, Cardiff.

A DOUBLE DEMONSTRATING EYEPIECE.—This eyepiece, which has been introduced by Mr. E. Leitz, enables two observers to view jointly an object under the microscope. It slips into the draw-tube of the microscope like an ordinary eyepiece. The field of view is common to both eyepieces and contains a pointer which either observer can direct upon any feature to which he wishes to draw attention.

The arrangement of the device is shown in Figure 304.

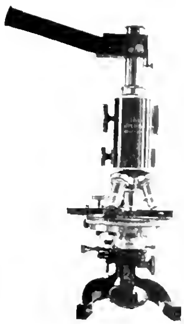


FIGURE 304.
The Double-demonstrating Eyepiece in position.

I and II are two prisms in contact and mounted above the diaphragm between the field lens and the eye lens of the eyepiece. The prism I has an isosceles cross section and its angles are 35°, 35°, and 110° respectively. The prism II is rectangular, and its angles are 35°, 55°, and 90°. The prisms are placed with those faces in contact which subtend the angles of 90° and 110° in such a manner as to leave between them a very thin film of air. This film is inclined at an angle of 30° to the axis of the eyepiece and partially reflects the emerging pencil of rays: about two-thirds of the rays pass through the prisms, and one third is reflected.

The image formed along the axis of the microscope is accordingly brighter than that produced by partial reflection. The centre line of the reflected pencil is inclined at an angle of 70° to the axis of the microscope. III is the prism, the lower surface of which reflects the pencil upwards at a convenient angle for observation. In order that the two observers may not be in each other's way the branch tube is fitted with a system of lenses which resembles a terrestrial eyepiece. The image as seen in the side tube is reversed with respect to that which appears in the axial eyepiece; but this would hardly affect the observer, especially since the oblique attachment of the side eyepiece already introduces unusual conditions of working.

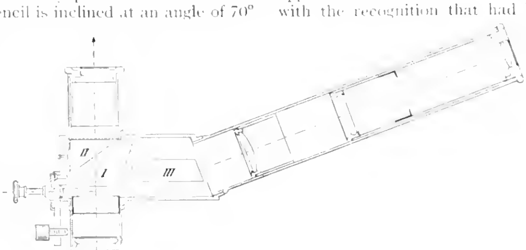


FIGURE 305.
Details of the Double-demonstrating Eyepiece.

As a matter of fact, the more expedient course is to adjust and focus the object through the principal eyepiece, as the image seen through it is brighter and easier to focus. The adjustment for one eyepiece furnishes also a clearly-defined image in the subsidiary eyepiece, provided the eyes of both observers can accommodate in a similar manner. The objective in conjunction with the field lens below the double prisms of the two eyepieces forms an image in the plane of the diaphragm below the double prism. This image and the pointer, being both in the plane of the diaphragm, are seen simultaneously in the principal and the subsidiary eyepieces.

The pointer can be moved backwards and forwards and turns on a pivot, so that its extreme end can be set at any point in the field. The Double Demonstrating Eyepiece is made in two powers, one having a magnification of four diameters, and the other of six diameters. In both cases the resulting images are sharp, colourless, and free from distortion. The fact that the image seen in the subsidiary eyepiece is fainter than the other is no serious drawback, as the eyepieces are solely intended for demonstrating purposes, and the demonstrator's acquaintance with the object will generally enable him to see every detail clearly under these less perfect conditions. When diffused daylight does not suffice to bring out fine details distinctly in the darker portions of the field, it will be necessary to use one of the artificial illuminators which are generally to be found in laboratories such as electric glow-lamps, arc lamps, Welsbach or acetylene lamps. With high power objectives it is generally advisable to set the draw tube of the microscope about one centimetre shorter than its standard length.

The double demonstrating eyepiece is also well adapted for the instantaneous photography of living bacteria, and other moving organisms illuminated by means of a dark ground condenser. It enables one to watch the object through the side eyepiece, and to defer the exposure until a favourable moment presents itself.

THE ROYAL MICROSCOPICAL SOCIETY PRESENTATION TO MR. FREDERICK A. PARSONS.—A very pleasing little ceremony took place at the meeting of the Royal Microscopical Society on June 19th. The President, Mr. H. G. Plimmer, F.R.S., presented to Mr. Frederick A. Parsons (on his retirement from the office of Assistant Secretary after sixteen years service) with an illuminated address and a cheque, on behalf of the Fellows of the Society. Mr. Plimmer further mentioned that the Council had reinstated Mr. Parsons as a Fellow of the Society, and had passed a resolution that all annual contributions in the future should be remitted. This announcement was received with great applause, and Mr. Parsons was evidently much pleased with the recognition that had been made of his efforts.

QUEKETT MICROSCOPICAL CLUB.—May 28th.—Mr. E. M. Nelson, F.R.M.S., wrote that he had examined a mount, supplied by Mr. H. F. Angus, of Mr. Siddall's diatoms, showing the so-called pseudopodia (see "KNOWLEDGE," May, 1912, page 193). Using a $\frac{1}{12}$-in. Leitz apochromat, structure like a spiral filament in a tube was observed. This was in a *Coscinodiscus*. In a *Biddulphia* the structure resembled a minutely-jointed antenna.

Mr. R. T. Lewis, F.R.M.S., read "A note on *Solpuga* (*ferox*?)." This genus is included in the fifth order of the Arachnida. About fifty species are known, all African. In length the adults measure from one to two inches and vary in colour from reddish-brown to dull grey. They are covered with hairs of several distinct kinds. They are armed with two pairs of enormously developed chelicerae placed near together side by side and opening vertically. Two large simple eyes are present. The cephalothorax is formed of six segments, the first three fused. Spinning organs are absent. No poison-sac or duct has been found. On the dorsal surface near the extremity of each of the chelicerae in the male, there is a curious organ, the flagellum, the function of which is unknown. Of the five pairs of lateral appendages the first are the pedipalpi, six-jointed. The first, second and third pairs of legs are also six-jointed. The fourth pair is very remarkable, and is eight-jointed, exclusive of the division of the tarsus, which has one long and six short joints in addition to the claws. These, like those of the second and third pairs are also dentated near the ends. Three out of the four joints nearest the body have five curious fan-shaped organs suspended from them by flexible stems which connect them with the tracheal and nervous systems. These are the malleoli, and measure about 1·7 millimetres across in the widest part. The convex lower edge of each fan is bordered with fine vertical striae about 2·5 μ apart. We have no knowledge as to the functional use of these appendages. Preparations and micro slides of *Solpuga* were exhibited in illustration of the paper.

Mr. A. E. Conrady, F.R.M.S., made "Some remarks on experiments on alternative microscopical theories."

ORNITHOLOGY.

By Hugh Boyd Watt, M.B.O.U.

WHITE STORK (*CICONIA ALBA*) NESTING IN CAPTIVITY.—Hitherto, the only records we have of this bird rearing its young in captivity in this country are from Kew Gardens in the years 1902 and 1903. In the Zoological Gardens, London, last year (1911) four eggs were laid and one bird hatched out, which did not survive. This year five eggs were laid and they have all been hatched out and, it is hoped, that some, at any rate, of the young may be successfully reared.

THE BRITISH BLACK-BACKED GULL.—Dr. Percy R. Lowe has separated the *Larus fuscus* of Linnaeus into two races, which he proposes to name *Larus fuscus fuscus* and *L. fuscus britannicus*. The last named is a new subspecies and, according to Dr. Lowe, sufficiently distinguished as a more western or light-backed race from the Scandinavian or more eastern, dark-backed form, to justify the opinion he has arrived at (*British Birds*, June 1912, Vol. IV, pages 2–7, with a plate).

THE BREEDING RANGE OF THE FULMAR IN THE BRITISH ISLES.—In the last two numbers of the *Scottish Naturalist* (May and June, 1912, pages 97–102 and 121–132) Dr. J. A. Harvie-Brown gives a detailed and informative account of the extension in recent years of the breeding quarters of the Fulmar (*Fulmarus glacialis*) on our northern coasts. The species has been long known as nesting in great numbers on St. Kilda, there being continuous historical evidence of this extending back for some two hundred and fifty years. A remarkable feature of this station was its isolation, none other being found nearer than Iceland and Spitzbergen, until the year 1838, when a settlement was made on the Faroes. On St. Kilda the numbers of the birds have considerably increased, but Dr. Harvie-Brown leaves it open to question whether those now nesting at other places came from St. Kilda or from more northern regions, or from both; and he also leaves for future discussion the probable cause or causes of the widespread colonisation which has taken place. In chronological order that process may be summarised as follows: In 1878 Foula was occupied; in 1886–7, North Rona and Sulisgeir; in 1889, Stack; from 1891 onwards, various places in Shetland, nearly twenty being now frequented in this group of islands; in 1897, near Cape Wrath and in 1900 at Dunnet Head (both on the Scottish mainland); from 1900 onwards, several places in Orkney; in 1902, Fair Isle, Flannan Islands, Handa, and Barra Head; in 1910, Shiant Islands; in 1911, Berriedale Head (Caithness) and in the same year Ireland was reached and Ulster and Mayo populated. Of the localities named only Ireland and Barra Head are south of St. Kilda, and all the places are smallish islands except the two in Ireland and three in Scotland.

It is interesting to recall that Darwin, in "The Origin of Species," says that the Fulmar is the most numerous bird in the world, but the grounds or authority for the estimate are not given.

PHOTOGRAPHY.

By Edgar Senior.

REVERSAL OF THE PHOTOGRAPHIC IMAGE.—In order to obtain a perfect negative of the subject being photographed, it is necessary that the exposure should be as correct as possible, over-exposure resulting in a flat and often very foggy image, while when still further prolonged "to a sufficient extent," causing a reversal of the first effect of the light action. Reversal, then, in its most complete form results in the formation of a positive, instead of a negative image upon development, or while the greater portion of the image may be negative, the rest will be positive, owing to the great difference in brilliancy between the objects photographed. An example of this kind is seen when including the image of the sun in a landscape, an exposure sufficient to bring out detail in the near foreground producing a reversal of the sun's disc. The cause of this phenomena can scarcely be considered as thoroughly established, owing chiefly to the uncertainty which exists as to the nature of the alteration brought about when light changes silver bromide in a gelatine plate into a developable condition. Experiment, however, has shown that the image, "as far as development is concerned," can be destroyed by quite a number of agents. Almost anything that will readily part with oxygen will do it; hence such substances as permanganate of potash, potassium bichromate, any of the ferric salts, ozone, peroxide of hydrogen are effective. There is still one other substance which has a destructive action upon exposed silver bromide and that is bromine. If a plate that has been exposed to light is treated with bromine water, the image will be destroyed. Its presence during exposure is accounted for on the hypothesis that it is liberated by the light's action, although it is an open question whether any halogen is set free during a normal exposure. There appears little doubt, however, that something of this nature does occur during a very prolonged one, and it only remains as to the length of time that must elapse before this change commences. In any case it has been shown that if a gelatine or other plate be soaked in a strong solution of sodium sulphite or potassium nitrite no reversal will occur during an unlimited exposure to light. These experiments therefore form strong evidence in favour of the argument that bromine in some way is the cause of the trouble. If the halogen acts in such a manner that it reconverts back to its original state the light-altered compound, its behaviour furnishes an example of reversible chemical action in which the products of the reaction will under certain conditions react with each other to re-form the original substance. As an example we may take the case of the preparation of hydrogen by the passing of steam over red-hot iron, when a reaction expressed by the equation $Fe_3 + 4\ H_2O = Fe_3O_4 + H_8$ occurs, but it is equally true that if Fe_3O_4 and hydrogen are heated together the reaction expressed by this equation occurs:—$Fe_3O_4 + H_8 = Fe_3 + 4\ H_2O$. Now under certain conditions either of these reactions may be carried to approximate completion, but if iron and steam be heated together in a closed vessel the iron will never be completely oxidised, because as soon as any Fe_3O_4 and H are formed they tend to react with each other to re-form H_2O and Fe, in other words the reaction is reversible, or can take place in either direction at the same time, and may be represented as follows:—

$$Fe + 4\ H_2O \rightleftarrows Fe_3O_4 + H_8$$

It has, however, been shown that under certain conditions the whole of the iron can be completely oxidized as expressed by the equation $Fe_3 + 4\ H_2O = Fe_3O_4 + H_8$, the conditions being that the hydrogen shall be removed from the sphere of action as fast as it is formed. In order to do this a large excess of steam over that shown in the equation is necessary, in order that the hydrogen may be swept away and so prevent it converting back to its original state some of the product of the first reaction. On the assumption then, that bromine is set free by the action of light we have an analogous case, in which the halogen will, unless removed, react with the altered silver salt, or it may be enter into combination with the gelatine and indirectly give rise to the formation of bodies which have an equally deleterious action upon the developable image. It is now thirty years ago since Sir William Abney in one of a course of Cantor lectures

FIGURE 306.

(1882) delivered before the Society of Arts, dealt with this subject of reversal, showing a film which had received an exposure of one minute behind a negative to direct sunlight, and yet the image obtained was quite free from any effects of reversal. This was explained as being due to the film having been treated with potassium nitrite which took up the bromine as fast as it was formed, and so prevented it from attacking the silver bromide that had been altered by light. And to use this scientist's own words: if you want to get rid of reversal you must give the plate something which will very rapidly absorb bromine, and which if possible is not organic. What was foreshadowed as being possible so many years ago, has now been practically realized by the discovery that certain salts or derivatives of hydrazine possess the required properties, and plates coated with emulsion containing these bodies have been placed upon the market by the Paget Prize Plate Company Limited, under the name of "Hydra" plates. By the courtesy of the Paget Company the writer has been able to try these plates, with the most gratifying results—subjects from which, owing to their great difference in brilliancy, it had been impossible to obtain satisfactory results previously, photographed most perfectly, there being not the slightest trace of reversal, and the invisible backing with which the plates are coated preventing halation, even with very prolonged exposures. The examples which form the illustrations to this article will, I think, speak for themselves, Figure 306 being a photograph of an incandescent electric light, taken on an ordinary rapid gelatine plate, while Figure 307 is the same lamp photographed under the same conditions on a Paget "Hydra" plate. In Figure 306 the image of the filament is entirely reversed, while in Figure 307 there is no sign of reversal, beyond which the increased brilliancy (luminosity) given with the "Hydra" plate is quite evident as well. The speeds of the plates employed were 250 H. and D. and the exposures given were forty minutes with stop F 22 although we found that complete reversal was obtained on the ordinary plate in ten minutes. The developer employed in both cases was a normal pyro-soda one, used in everyday work, so that no departure was made from ordinary procedure. When the degree of over exposure is very great, "some forty-times," then a special developer has to be used. This, however, is supplied in a convenient form by the makers of the plates.

EXPOSURE TABLE FOR JULY.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and lens aperture F.16.

Day of the Month	Condition of the Light	Time of Day: 10 a.m. and 2 p.m.	8 a.m. and 4 p.m.	6 a.m. & 6 p.m.	5 a.m. and 7 p.m.
July 1st	Bright	·09 sec	12 sec	2 sec	45 sec
,, ,,	Dull	·18 ,,	·24 ,,	4 ,,	·9 ,,
July 15th	Bright	·09 sec	·13 sec	·27 sec	·52 sec
,, ,,	Dull	·18 ,,	·26 ,,	·52 ,,	·97 ,,
July 30th	Bright	·09 sec	·13 sec	·3 sec	·64 sec
,, ,,	Dull	·18 ,,	·26 ,,	·6 ,,	1·27 ,,

Remarks.—If the subject be a general open landscape take half the exposures given here.

FIGURE 307.

AUTOCHROME SCREEN.—From Messrs. J. H. Dallmeyer, Ltd., of 25, Newman Street, Oxford Street, we have received an Autochrome screen in optical flats suitable for use with high-class anastigmats, telephoto, process and other lenses. These screens are made in diameters varying from one and a half inches to three inches and at prices from twenty-two shillings to fifty shillings. They are worked to an accuracy of one five hundred thousandth part of an inch.

We have examined this screen and consider that it fully bears out the claim made for it by the makers, and the high reputation enjoyed by Messrs. Dallmeyer should be sufficient guarantee of its excellence.

PHYSICS.

By Alfred C. G. Egerton, B.Sc.

SEMI-OILY LIQUIDS ON A WATER SURFACE.—When a drop of liquid is placed on a water surface the effect produced depends on the solubility of the liquid. An oil forms a permanent film; but a slightly soluble liquid forms a film which breaks up into globules. The globules are formed by indentations spreading rapidly into the films and causing partition. Sometimes the globules are projected violently across the surface of the water. Mr. C. R. Darling has made a careful study of these effects which he has brought to the notice of physicists: his last paper to the Physical Society on the subject was read on Friday, May 1st. He has investigated many organic liquids, among the most interesting being aniline, dimethylaniline, quinoline, and 1:3:4 xylidine. Aniline, after spreading into a film, collects into one or more large globules, which become indented round the edges and then recover their shape with partition of a few small globules. Dimethylaniline breaks up into small globules much more rapidly; the indentations spread and bifurcate very rapidly, dividing the film into globular portions.

Quinoline behaves very much like dimethylaniline, but works slower. The small globules formed in this case finally become rings which are quite permanent and distinctive of quinoline.

Xylidine and orthotoluidine form globules which become indented on one side and move rapidly across the surface usually away from the side where the indentation has occurred; the globules become reniform in shape. The globules thus gradually break up into smaller globules.

Mr. Darling's explanation of these interesting effects is the following:—The surface tension of the water is weakened by the solution of the liquid. The opposing tensions then overcome that of the water, with the result that the film is drawn back and indented. The strength of the air-water tension is then partially restored by the sinking or diffusing of the dissolved part so that the drawn-up mass again tends to spread. Indentations would therefore occur where the air-water tension had become most weakened; and if the opposing tensions were strong enough, the globule would be drawn across the surface of the water. Equilibrium would be established when the air-water tension had become uniformly weakened and the opposing tensions possessed a resultant tension equal to that of the soiled water.

It would be interesting to investigate the effects of films of liquids on solvents such as acetone, alcohol, and so on, instead of water; perhaps similar interesting phenomena would be obtained.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

EGG-TOOTH OF BIRDS.—One is glad to hear something more in regard to the so-called egg-tooth of young birds, which is none the less interesting that it has nothing to do with teeth, being simply a horny knob. If it is of use in breaking through the egg shell, which seems in some cases at least very doubtful, it is used only once. As everyone knows, it soon falls off. The fact suggests the question whether it may not be a derivative of some older structure with a different use, for this is a common thing in organic evolution, that the apparently new should arise from the very old. Some recent observations by E. Rosenstadt suggest that the egg-tooth of the upper jaw, and its corresponding vestige on the lower jaw, may be a relic of an ancient armature, older than the horny sheaths we are familiar with. In the first place, the egg-tooth above and the vestige below become horny before there is any other cornification on the jaws. In the second place, the process of making horn in the egg-tooth is different from that elsewhere. Each of the skin cells concerned turns wholly into horn-fibres, nucleus and all, whereas in ordinary cases, as in the horny covering of the jaws, only the mantle of each cell is turned into horn.

LOCOMOTION IN SNAILS.—When we watch a snail creeping on a pane of glass we see beautiful waves of contraction passing along the "sole of the foot," *i.e.*, the snail's muscular ventral surface. The foot works partly as a holdfast, adhering by its mucous secretion, or by acting like a sucker, or by both means. Professor G. H. Parker has studied numerous Gastropods and finds that the locomotion may be accomplished without (arhythmic) or with (rhythmic) the pedal waves. In rhythmic locomotion the waves may run from posterior to anterior (direct) or the reverse (retrograde), but a snail never moves backwards. The foot may show one, two, or four series of waves. When there are two series, the waves may be alternate or opposite.

"The pedal wave is an area of the foot that is lifted off the substrate as compared with the rest of the foot and thereby freed more or less from adhesion. It is also the region of the foot that moves forward, the rest of the foot remaining temporarily stationary. Locomotion is the cumulative result of local forward movement on the part of one section of the foot after another till the whole foot has been moved. The same type of muscular movement as that seen in rhythmic locomotion can be present in a diffuse form (not wave-like) in a gastropod foot and will result in locomotion."

EFFECT OF ALCOHOL ON GENERATIONS OF ROTIFERS.—Dr. D. D. Whitney studied four strains of parthenogenetic rotifers, originally descended from one female, for twenty-eight successive generations. One strain was kept as a control, the other three strains were kept in a quarter per cent., a half per cent., and one per cent. solution of alcohol. The rate of reproduction was lessened in the alcoholic strains. Those of the one per cent. alcoholic strain showed in the XI–XV generations a decidedly increased susceptibility to copper sulphate used as a test of resistance. When the alcohol was removed in generations XI–XXII, the rate of reproduction increased noticeably in the first generation, and in the second equalled that of the control. Individuals of the second generation after the alcohol had been removed were no more susceptible to copper sulphate than those which had never been alcoholised. The general conclusion is that the grand-children possess none of the defects caused by alcohol in the grand-parents. Alcohol in the percentages used affects only the body tissues. If the animals were subjected to it indefinitely, generation after generation, the race would probably become extinct because of its "lowered resistance power" to unfavourable conditions. "However, if the alcohol is removed it is possible for the race to recover and to regain its normal condition in two generations, thus showing that the germ substance is not permanently affected by the alcohol."

MEDUSOID OF MICROHYDRA.—One of the simplest of the freshwater polyps, which have doubtless evolved from a marine stock, is *Microhydra ryderi* Potts, reported some years ago from North America. It was known to liberate a minute Medusoid. In 1909, Professor Goette, of Strassburg, recorded its occurrence in Germany. In the warm summer of last year its medusoid stage—which has been carefully searched for—was found by W. Schorn, in Finow Canal, near Eberswald.

A KNOWLEDGE OF THE ORIGIN AND EARLY HISTORY OF THE ROYAL HORTICULTURAL SOCIETY AS DERIVED FROM CONTEMPORARY MEDALS, CARICATURES AND OTHER RARIORA.

By A. M. BROADLEY.

Author of "Dr. Johnson and Mrs. Thrale.

THE foundation of the Horticultural Society of London in the year before Trafalgar, and its incorporation by a Charter of Incorporation, granted by King George III in 1809, the year in which he celebrated his Jubilee, were the result of the steady progress made in garden-craft during the greater part of the eighteenth century. The successful Horticultural Exhibition of 1912, the greatest effort of the kind ever conceived and carried out either in England or on the Continent, may be regarded as commemorating the centenary of the powerful and progressive association which, ever since its first inception, has accomplished so much for the advancement of horticulture both in its scientific and practical aspects. It was towards the middle of the century in which Sir Joseph Banks [1743 - 1820], Daniel Charles Solander [1736 - 1782], Gilbert White [1720-1793] and Lancelot Brown [1715-1783] (see Figure 308) flourished, that the calling of the nurseryman and the florist attained the importance which is reflected in the ornate trade-cards and seed-lists issued by Henry Scott, of Weybridge, John and George Telford, of York (both of which are now reproduced in Figures 310 and 311) and many others. Outward and visible signs of the good work done by Lancelot Brown (better known by his more familiar sobriquet of "Capability"), the pioneer of English landscape-gardening (whose portrait is now given), are still abundant. Brown, like Banks, received much encouragement from the sovereign to whom posterity has given the name of "Farmer George," whose love of gardening was as great as his fondness for cattle-rearing. It was "Capability" Brown, the reviver of the natural style of landscape-gardening, who laid out the grounds of Kew and Blenheim, in addition to designing a great number of country houses. In 1770 Brown served the office of High Sheriff of Huntingdon. While superintending the works at Kew he is said to have spoken some plain truths to the King, which Sir Joseph Banks was possibly too much of a courtier to utter, although he also had a serious difference with His Majesty about the introduction into England of the merino sheep. The business founded by "Capability" Brown is still in existence, and it is certainly a notable coincidence that Mr. Edward White, to whose untiring efforts and spirit of enterprise much of the success of the recent great exhibition at Chelsea may be fairly attributed, is connected with it.

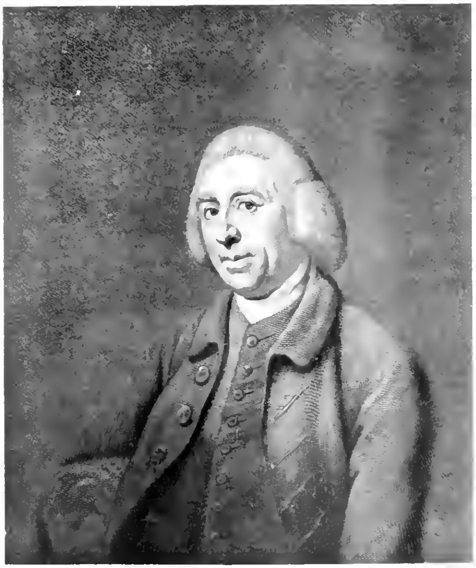


FIGURE 308.

Lancelot ("Capability") Brown, the father of English landscape-gardening, 1715-1783.

In the pages of Mr. Edward Smith's interesting and carefully-compiled "Life of Sir Joseph Banks," published last year by Mr. John Lane, we find a good deal of information concerning the foundation of the Royal Horticultural Society and the early enthusiasm for garden-craft of which its establishment was the outcome and practical result. The gardens of the genial President of the Royal Society, both at Spring Grove and Revesby Abbey, were equally wonderful. The total disappearance of the former, through "suburban encroachment," is to be sincerely regretted. The grounds of Revesby still retain much of the luxuriant beauty which the efforts of Sir Joseph Banks and his wife and sister imparted to them. We are indebted to Mr. Smith for a picture of Spring Grove as it appeared about the time the

Horticultural Society of London came into existence. It [illegible] and possibilities of a large and [illegible]. The pond from which

FIGURE [illegible].
A Trade Card of a Haymarket Florist in 1780.

Spring Grove derived its name was the scene of various experiments. One of these was the raising of the American Cranberry upon an artificial island, and the growing of *Zizania aquatica*, a singular grass used for food by the Indians in Canada, from seeds imported in 1791. It was, however, in the improvement of apples, peaches, grapes and figs that Sir Joseph was most successful. A great feature was also made of strawberry-growing at Spring Grove, where Banks successfully popularized the system of mulching with straw. Mr. Smith says: "Many new importations of flowers are on record which were first planted in Spring Grove.

FIGURE 510.
Eighteenth Century Heading of the Seed Catalogue of John and George Telford of York.

Rosa banksiae was sent by William Kerr, from China to Kew, and also to Banks's garden, where it became a great favourite, and much attention was paid to its cultivation. Isaac Oldaker (Lady Banks's gardener) submitted it to the Royal Horticultural Society in 1820, remarking that "by care it had been transformed from an insignificant greenhouse plant into a hardy and splendid creeping shrub." The Paeony was another of the personal triumphs of Sir Joseph Banks. It was first cultivated at Kew, but in 1805, the Double Scented Paeony was added to the glories of Spring Grove. As early as 1789, Banks exhibited the Hydrangea to his friends in Soho Square. It has since become the parent of a numerous progeny. As might be expected the scientific efforts of Banks made him the target of literary and pictorial satire. He was not spared

FIGURE 511.
Eighteenth Century Trade Card of Henry Scott of Weybridge.

either by James Gillray or John Wolcot, both of whom shewed little mercy to George III. In the matter of horticulture, as in the graver concerns of politics, "the scoffer was abroad."

Daniel Charles Solander had been recommended to English naturalists by Linnaeus himself. In 1768, he accompanied Sir Joseph Banks on Cook's voyage in the "Endeavour," and four years later went with him to Iceland. Until he was made Keeper of Printed Books at the British Museum he acted as secretary and librarian to Banks in Soho Square. We have caricatures of both Banks and his fellow-worker, Solander, published about 1770 by Darby of the Strand. They were both represented as Macaroni

By the courtesy of Mr. John Lane.

FIGURE 312.
A Caricature of Solander.

exquisites. Banks is portrayed (see Figure 313) in the act of endeavouring to capture a splendidly-coloured butterfly with a bat-shaped fly-catcher. Below the design are the words:

> I rove from pole to pole. You ask me why.
> I tell you truth, and catch a fly.

The "Simpling Macaroni" is an etched whole-length portrait of Solander (see Figure 312), holding in one hand a large flowering plant, and in the other a naturalist's knife, on the blade of which is written the maker's name "Savigny," one of the well-known eighteenth-century makers of scientific instruments. Below we read:—

> Like Soland Goose from frozen zone I wander
> On shallow Banks grow fat Solander!

John Wolcot and Thomas Rowlandson joined forces to represent Sir Joseph Banks as a promoter of a "fly club" (see Figure 315), and John Gillray produced a remarkable cartoon in which he depicted the "Great South Sea Caterpillar, transformed into a Bath Butterfly" (see Figure 314).

> Enter, Sir Joseph, gladdening Royal eyes.
> What holds his hand? A box of Butterflies!
> Grubs, nests, and eggs of humming - birds to please,
> Newts, tadpoles, brains of beetles, stings of bees.

By the courtesy of Mr. John Lane.

FIGURE 314.
Gillray's Cartoon of Sir Joseph Banks.

Wolcot devoted at least three odes to the ridicule of Banks, but they do not appear to have had any more serious effect on the successful grower of strawberries at Spring Grove, than fifty similar attacks by the same ruthless hand had on the King and Queen at Windsor, Weymouth and Kew. It was reported that the Royal Princesses were "vastly amused," and so possibly were Mrs. and Miss Banks.

To John Wedgwood, of Betley, in Staffordshire, must, according to Mr. George Smith, be credited the original idea from which the Royal Horticultural Society sprang. His identity has, curiously enough, often been confused with that of Josiah Wedgwood, the famous potter. John Wedgwood, of Betley, was an enthusiastic horticulturist and naturalist, and an intimate friend of Thomas Andrew Knight, who eventually became President of the newly-formed association, which certainly owed much of its early success to the inspiriting influence of Spring Grove. It was during the last decade of the eighteenth century that the example set by Banks was largely followed by his numerous friends and acquaintances, many of whom profited by his advice in improving their existing gardens and building new hot-houses. "One of these friends," Mr. George Smith informs us, "was Charles Greville, the philandering nephew of Sir William Hamilton, who had a fine garden at Paddington Green, and, in his latter years (having presumably sown his wild oats), proved a good horticulturist and successful importer of exotics." The success of Mrs. Joseph Marryat's garden at Wimbledon is said to have rivalled that achieved at Kew. It was on the afternoon of March 7th, 1804, when England was in the throes of the Great Terror, that John Wedgwood induced Charles Greville, Sir Joseph Banks, and

By the courtesy of Mr. John Lane.

FIGURE 313.
A Caricature of Sir Joseph Banks.

Messrs. Salisbury, Aiton, Forsyth, and Dickson to foregather in a room behind Mr. Hatchard's shop in Piccadilly. Mr. Smith does not give the name of Thomas Andrew Knight amongst those present, but in the paper read at Chester on August 4th, 1896, by Sir Trevor Lawrence, P.R.H.S., the project of founding the Royal Horticultural Society was wholly attributed to Thomas Andrew Knight, F.R.S., "a name associated with the Society during a long course of years, and ever regarded with the highest honour by all connected with it." "Mr. Knight," says Sir Trevor Lawrence, "had devoted much attention to scientific horticulture and vegetable physiology, on which subjects he had communicated several papers to the Royal Society. He lived in Herefordshire in the midst of a cyder and perry country, and had been struck by the unskilful and unscientific management of the surrounding orchards. He put himself into communication with Sir Joseph Banks, P.R.S., Mr. R. A. Salisbury, Messrs. Aiton and Forsyth, the royal gardeners and others, the result being that on March 7th, 1804, the new society was founded." The name of Mr. John Wedgwood does not even occur. Mr. Smith, on the other hand, declares him to have been at once the head and moving spirit of those who desired to found the London Horticultural Society, being "dissatisfied with the prevailing habit of leaving all to the gardener, who generally pursued the dull routine of his predecessor, without science and with little intelligence." Those who assembled on that eventful afternoon in the parlour of John Hatchard felt sure of being able "to improve almost every esculent plant or fruit by the adoption of system and foresight in gardening operations." Sir Trevor Lawrence makes T. A. Knight the suggestor of the Piccadilly gathering; Mr. George Smith, quite as distinctly, assigns that position to John Wedgwood.

FIGURE 315.
Rowlandson's—"A Feast at the Fly Club."

The premises of John Hatchard have been lately rebuilt, and the façade overlooking Piccadilly is once again very much what it was in 1804 when Knight or Wedgwood, or both, called their friends together there to form the Horticultural Society of London. That Sir Joseph Banks was of the party there can be very little doubt. Nineteen years ago Mr. Arthur L.

FIGURE 316.
George Cruikshank's Celebrated Caricature of the Horticultural Society in 1825.

Humphreys, who is now the head of the house of Hatchard, told the story of the firm in an excellent little book entitled "Piccadilly Bookmen." Both in 1803 and 1804 John Hatchard was busily occupied in producing those broad-sheets which did so much to stimulate the popular hatred of "Little Boney" and the national resolve to resist his aggression to the death. The parlour at "Hatchard's" was now a place of rendezvous for ardent patriots and politicians as well as for the bishops and clergy of the Low Church Party, who had lately seceded from Rivington's house, at the sign of the Bible and the Sun in St. Paul's Churchyard. Scott, Crabbe and Sydney Smith were all habitués at "Hatchard's" and the latter, in 1810, commenced an article on "Public Schools" in *The Edinburgh Review* by observing that:—"There is a set of well-dressed prosperous gentlemen who assemble daily at Mr. Hatchard's shop, clean, civil personages well in with the people in power, delighted with every existing institution, and almost with every existing circumstance: and every now and then one of these personages writes a little book, and the rest praise that little book, expecting to be praised in their turn for their own little books, and of these little books thus written by these clean, civil personages, so expecting to be praised, the pamphlet before us appears to be one."

FIGURE 317.
The Knightian Medal of the Royal Horticultural Society.

In the very next sentence Mr. Humphreys solves the historical doubt for which Mr. George Smith and Sir Trevor Lawrence are jointly responsible, for he says:—"While speaking of the place in the early days as a rendezvous, it may be appropriate to mention the fact that 'The Royal Horticultural Society' received its first definite foundation on the 7th March, 1804, at a meeting held here. Among those who thus met and inaugurated that flourishing Society were *John Wedgwood*, *Andrew Knight*, the Earl of Dartmouth, and Charles Greville. It is a matter of tradition, amounting almost to a certainty, that a room now used for despatching orders was once a private parlour set aside for such gatherings as met when the Horticultural Society was first started."

It is a curious coincidence that in 1804 the Empress Josephine (as keen a lover of garden-craft as Lady Banks) was arranging for the importation of seeds and rare plants from the country her husband was threatening to invade and annihilate. It may also be noted that the next social movement to be set going at Hatchard's was the "Oretinian Society," which was in reality the primitive inception of a matrimonial agency.

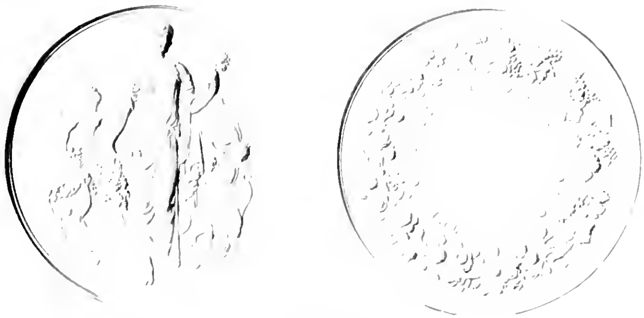


FIGURE 318.
The Flora Medal of the Royal Horticultural Society.

Four of the early medals of the Royal Horticultural Society are now reproduced.

The medal presented to Sir Christopher Hawkins, Bart., on 5th March, 1816 (see Figures 320 and 321), and the Sir Joseph Banks (see Figure 319), belong to that year, although the reverse of the former bears the date of the foundation of the Society, viz., 1804, with the words *Alienis mensibus aestas.* The Thomas Andrew Knight medal (see Figure 317) and the later Royal Horticultural Society's Flora medal, designed by Wyon (see Figure 318), are dated 1836. Other associations connected with

FIGURE 319.
The Banksian Medal of the Royal Horticultural Society.

FIGURE 320.
Large Medal presented to Sir Christopher Hawkins, Bart., on the 5th of March, 1816. Obverse.

garden craft soon came into existence, of which one of the best known and most successful was the South London Floricultural Society (see Figures 322 to 324).

The prosperity and practical usefulness of the Royal Horticultural Society may be said to have commenced from the very year of its

FIGURE 321.
The reverse of the Medal presented to Sir Christopher Hawkins, bearing the motto *Alienis mensibus aestas.*

FIGURE 322.
Obverse of a Medal of the South London Floricultural Society.

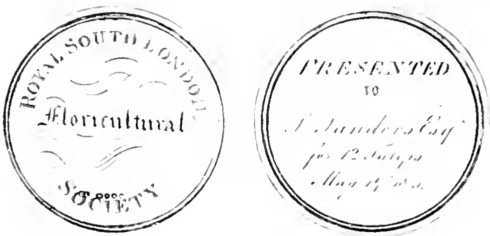


FIGURE 323.
A Medal of the South London Society after it had obtained the title of Royal.

FIGURE 324.
Reverse of the Medal seen in Figure 322.

foundation. "From the very beginning," says Mr. George Smith, "it justified its existence, and it remains to-day one of the most splendid legacies of that awakening period." Sir Joseph Banks, an indefatigable reader of papers at the evening meetings, had no longer any need to write (except jocularly)—"my gardener, who is also my master." One of the best remembered of these essays was that dealing with the practice of mulching strawberry plants with straw. Another was devoted to the cultivation of the American cranberry at Spring Grove. Thomas Andrew Knight, the learned author of the "*Pomona Herefordiensis*," who succeeded Lord Dartmouth as President of the Royal Horticultural Society, was an intimate friend of Sir Joseph Banks. His letters on gardening form an important section of the Banks correspondence preserved at South Kensington. On New Year's Day, 1826, George Cruikshank, having done with "Little Boney" and Queen Caroline, seems to have turned his attention to the vigorous Royal Horticultural Society. Hence the caricature entitled "Exhibition Extraordinary" which figures as No. 1331 in G. W. Reid's list (1871), and as No. 1155 in that of Captain R. J. H. Douglas (1903). We are indebted to Mr. Reid for some interesting identifications of early nineteenth-century adepts in the garden-craft and members of the Royal Horticultural Society. He writes:—"A meeting of the Horticultural Society with the company assembled, and described as part of the Exhibition, commencing with 'The Pink of Fashion, or Dandy Lion,' and ending with the 'Hortus Cantab, propagated at Newmarket.' The articles on the table have affinities to popular sensations and inventions. A volume of the Society's *Transactions* is lying open on one of the seats, where is an essay on a radish, illustrated with a highly finished engraving. The pictures against the wall are those of Sir Joseph Banks and Lady Ann Monson. Amongst the persons present are: Mr. West, Alderman Cox, Mr. Rogers, Mr. Wilbraham, Mr. Richard Salisbury, Mr. Sabine, Mr. Elliott, Mr. Turner, Mr. Motheaux, Captain Maxwell, Dr. Henderson, Lord Verulam and Mr. Labouchere." The presence of Mr. T. A. Knight, who held the presidency of the Royal Horticultural Society down to the year of Queen Victoria's Coronation, seems to have again escaped the notice of the chronicler, who thus describes the work of an artist whose powers of satire were not less pungent than those of James Gillray and Thomas Rowlandson.

BRIEF NOTICES OF BOOKS.

The following books have been received since the last number of "KNOWLEDGE" went to press. Those of particular interest to our readers will be reviewed at length in due course

Science of the Sea.—Prepared by the Challenger Society. Edited by G. HERBERT FOWLER, B.A., Ph.D., F.L.S. 452 pages. 217 figures. 8 charts. 8-in. × 5½-in.

(John Murray. Price 6/- net.)

This is a collection of essays by various writers, which will be of great use to those who have spare time on board ship, or who wish to take up oceanic work for its own sake.

The House Fly.—By L. O. HOWARD, Ph.D. 312 pages. 40 illustrations. 8½-in. × 5½-in.

(John Murray. Price 6/- net.)

We have already waked up in England to the fact that flies are great carriers of disease, and a simple and straightforward book dealing with the subject will prove of great use to those whose responsibilities cause them to be interested in the matter, while it is hoped that it will bring home to others the truth of what perhaps they would otherwise consider to be a doubtful rumour.

Bees Shown to the Children.—By ELLISON HAWKS. 120 pages. 39 plates. 6¾-in. × 4¾-in.

(T. C. & E. C. Jack. Price 2/6 net.)

This book is well calculated to interest children. The pictures will no doubt encourage them to study the insects dealt with at first hand.

Cambridge County Geographies.—*Dumfriesshire.*—By JAMES KING HEWISON, M.A., D.D. 176 pages. 59 illustrations, 4 maps. *Renfrewshire.*—By FREDERICK MORT, M.A., B.Sc., F.G.S. 177 pages. 55 illustrations, 8 maps. *Perthshire.*—By PETER MACNAIR, F.R.S.E., F.G.S. 180 pages. 72 illustrations, 5 maps. 7½-in. × 5-in.

(The Cambridge University Press. Price 1/6 each.)

We have already commented favourably on some of the earlier volumes in the series entitled Cambridge County Geographies. As is usual, a number of interesting facts not found in ordinary geographies are included: such as details of the people, the industries, antiquities, and natural history of the county, as well as its roll of honour. In the book on Dumfriesshire are mentioned Sir William Jardine the naturalist, Kirkpatrick Macmillan who invented the first gear-driven bicycle, and Sir John Richardson who went with Franklin to the polar regions as surgeon and naturalist. Renfrewshire can claim James Watt, while Perthshire has but few scientific worthies.

The Gateways of Knowledge.—By J. A. DELL, M.Sc. (Vict.). 171 pages. 51 illustrations. 8-in. × 5½-in.

(The Cambridge University Press. Price 2/6.)

This is essentially a book of practical work and particularly to be commended.

Further Researches into Induced Cell-Reproduction and Cancer.—By H. C. ROSS, M.R.C.S. 125 pages. 9 illustrations. 9-in. × 5¾-in.

(John Murray. Price 3/6 net.)

This contribution to the subject is concerned with the theory that cell-proliferation and possibly cell-development are directly brought about by chemical agents set free by cell-death.

Johnston's Handbook to the Celestial Globe.—32 pages. 7¼-in. × 5-in.

(W. & A. K. Johnston. Price 1/-.)

This book is intended to accompany Johnston's Celestial Globes, and gives much information and suggests a number of problems which can be solved by the celestial globe, such as the finding of the sun's declination for any given day or the beginning, end and duration of twilight at any given place on any given day.

The People's Books.—*The Foundations of Science.*—By W. C. D. WHETHAM, M.A. 94 pages. 2 illustrations. *Inorganic Chemistry.*—By PROFESSOR E. C. C. BALY. 96 pages. *Radiation.*—By P. PHILLIPS, D.Sc. 94 pages. 34 illustrations. *Lord Kelvin.*—By A. RUSSELL, M.A. 94 pages. 1 illustration. *Francis Bacon.*—By PROFESSOR A. R. SKEMP. 94 pages. 1 illustration. *A Dictionary of Synonyms.*—By AUSTIN K. GRAY, B.A. 91 pages. 6½-in. × 4¼-in.

(T. C. & E. C. Jack. Price 6d. net each.)

For the price of a monthly magazine those who are interested in science and scientific workers can buy a book by a well-known man which is convenient to carry about. Everyone should read the lives of Bacon and Kelvin, and while the volumes on various sciences can be picked out as the taste of the reader lies, others such as the one on Synonyms are generally useful as books of reference.

Laboratory Test Cards. 1st, 2nd, and 3rd year.—By JOHN HON, M.A., B.Sc., and HUGH JAMIESON. 6-in. × 4¼-in.

(The University Tutorial Press. Price 1/- net each year.)

These, as the name states, are cards, and contain practical instructions for three years' work, to which are added other cards giving answers and hints. The first year deals with measurement and matter, the second with heat and the third with chemistry.

We give the first paragraph of instructions from the third year. "Describe what happens when the powder given you is heated in a glass tube, test any gas evolved with litmus, lime water, glowing splinter, a lighted taper, and note all that happens." In the card of hints, we find that potassium chlorate and nine other substances are suggested for this experiment.

A Laboratory Notebook of Physics.—By S. A. MCDOWALL, M.A. Section 1:—Measurement and Hydrostatics. 20 pages. Section 2:—Heat. 62 pages. Section 3:—Light. 112 pages. Section 4:—Magnetism, Electrostatics, Current Electricity. 166 pages. 9¼-in. × 7-in.

(J. M. Dent & Sons. Price—1/9d.; 2, 3 & 4, 1/- net.)

Many good teachers know how important it is to furnish their students with practical instructions, which should be inserted in a notebook side by side with drawings or other records of the experiments or investigations suggested. No doubt sheets specially prepared for each lesson and coming fresh to the students are the best, but many teachers have no time to spend in getting ready their work in this way, and Mr. McDowall's instructions have the advantage of being printed in the actual notebooks.

The Physiology of Protein Metabolism.—By E. P. CATHCART, M.D.—142 pages. 9¾-in. × 6-in.

(Longmans, Green & Co. Price 4/6 net.)

This monograph consists of a discussion of the more important results published during the last decade, and their bearing upon the work of the early investigators.

Romance of Science Series.—*Chemical Research and National Welfare.*—A lecture delivered by Professor EMIL FISCHER. 80 pages. 7-in. × 5-in.

(The Society for Promoting Christian Knowledge. Price 1/6.)

It is useful for the general public to be reminded of what science does for the community; for as soon as a discovery is put to practical use it seems almost always to be looked upon as part of commerce. We hope that this book on chemical research will be followed by others dealing with our indebtedness to different sciences.

Preventable Cancer.—*A Statistical Research.* By ROLLO RUSSELL. 267 pages. [illegible] in. × 5¼ in.

(Longmans, Green & Co. Price 4/6 net.)

The author has collected together statistics dealing with cancer which cannot fail to be of interest and value. The freedom from cancer of monasteries, where the diet is simple, is one of the interesting points touched upon.

Text Books of Physical Chemistry.—Edited by SIR WILLIAM RAMSAY, K.C.B., F.R.S. *Spectroscopy.* By E. C. C. BALY, F.R.S. 687 pages. 180 illustrations. 7½-in. × 5-in.

(Longmans, Green & Co. Price 7/6 net.)

The first edition of this book appeared in April, 1905, and the fact that a new one has been called for shows how useful the work has been found.

Fungoid Diseases of Agricultural Plants.—By JAKOB ERIKSSON, Fil.Dr. 208 pages. 117 illustrations. 8¾-in. × 5½-in.

(Baillière, Tindall & Cox. Price 7/6 net.)

The number of fungoid pests to which cultivated plants are liable is so great, and their effect so far-reaching, that all contributions to the subject will be welcome. The manuscript of the English edition of Dr. Eriksson's book has been read through by Mr. George Massee, so that the technical terms may be relied upon.

Report on the progress and condition of the U. S. National Museum for the year ending June 30th, 1911.—147 pages. 9¼-in. × 6-in.

(Smithsonian Institute.)

The report records that the new building was finished on June 20th, 1911, six years after it was begun, and deals also with its occupation, in addition to the usual accounts as to what has happened in the various departments.

Oil Finding.—By E. H. CUNNINGHAM CRAIG, B.A., F.G.S. With an introduction by SIR BOVERTON REDWOOD, Bart. 195 pages. 13 plates. 18 figures. 9-in. × 5¾-in.

(Edward Arnold. Price 8/6 net.)

This book, it is anticipated, will be of use to those who are about to invest in petroleum undertaking, or who are shareholders in petroleum projects which are of an exploratory nature.

Nature Study Notebook.—By GEORGE H. GREEN. 63 pages. With many illustrations. 6¾-in. × 4¼-in.

(J. M. Dent & Sons. Price 6d. net.)

This small book is one of the Educational Journey Series, and is presumably intended to bring before the notice of town children some of the matters with which they will meet on their rounds. A few common animals are described, details are given of plant associations, while the sixth chapter tells something about agriculture and agricultural processes.

A Handbook of Nursing.—By M. N. OXFORD. 319 pages. 7½-in. × 5¼-in.

(Methuen & Co. Price 3/6 net.)

This is the sixth edition of a book which first saw light in 1900.

In Light and Darkness—Hope!—By IRENE E. TOYE WARNER. 80 pages. 5¼-in. × 4½-in.

(Kegan Paul, Trench, Trubner & Co. Price 1/6.)

This little book of verses by Miss Toye Warner, known to our readers as an astronomer, is dedicated to another of our contributors, Mr. W. F. Denning.

Spiders. By CECIL WARBURTON, M.A. 136 pages. 13 illustrations. *Rocks and their Origin.*—By G. A. J. COLE. 175 pages. 19 illustrations. *The Origin of Earthquakes.*—By C. DAVISON, Sc.D., F.G.S. 144 pages. 26 illustrations. 6¾-in. × 5-in.

(The Cambridge University Press. Price 1/- net each.)

Mr. Warburton's book occupies itself with the habits of spiders, with the spinning of webs, with gossamer and water spiders, as well as those which jump and seize their prey.

Those who know Mr. Grenville Cole's writing will welcome his contribution on rocks and their origin, while readers of "KNOWLEDGE" interested in Earthquakes will recall Dr. Davison's contributions to our columns, and we are glad to hear more about the phenomena in question.

We have also received the following books:—

Algebra for Beginners. With Answers.—By C. GODFREY, M.V.O., M.A., and A. W. SIDDONS, M.A. 272 pages. *Examples in Numerical Trigonometry.*—By E. A. PRICE. 90 pages. 38 illustrations. *Numerical Trigonometry.*—By J. W. MERCER. 157 pages. 61 illustrations. 7½-in. × 5-in.

(The Cambridge University Press. Price 2/6, 2/-, 2/6.)

The Mineral Kingdom. Parts 21 and 22.—By Dr. REINHARD BRAUNS. Translated, with additions, by L. J. SPENCER, M.A., F.G.S. 8 pages 5 plates and 16 pages 5 plates respectively. 12-in. × 9-in.

(Williams & Norgate. Price 2/- net each.)

Catalogue of 2,013 Stars between 35° and 37° S. Dec.—By W. ERNEST COOKE. 122 pages. 12¼-in. × 10-in.

(Fred. W. Simpson, Perth, Australia.)

Astrographic Catalogue. 1900·0. Perth Section. Dec. 31° to −41°. Vol. I.—By W. ERNEST COOKE, M.A., F.R.A.S. 52 pages. 12-in. × 9¾-in. Vol. IV. 72 pages. 12-in. × 9¾-in.

(Fred. W. Simpson, Perth, Australia.)

NOTICES.

THE HAMPSTEAD SCIENTIFIC SOCIETY.—From the Annual Report for the year 1911 it is evident that the Hampstead Scientific Society is doing excellent work in astronomy, natural history, and photography, each of which is dealt with by a separate section, as well as through the meetings of the Society generally.

THE SEISMOLOGICAL SOCIETY OF AMERICA. The current Bulletin of this society contains an interesting article on Professor John Milne, as well as a most useful paper on the choice of a seismograph, in which the many forms of the instrument are described and illustrated.

BOOKS ON LONDON. We have received from Messrs. Sotheran & Company a beautifully illustrated catalogue of books and prints dealing with London and its neighbourhood, as well as social memoirs and diaries and some fine engravings, not to mention a series of one hundred and fifty pictures and caricatures dealing with fashions in head dress during the eighteenth and early nineteenth centuries.

SMITHSONIAN MISCELLANEOUS COLLECTIONS. Volume LVII, numbers 6, 7 and 8, deal with Cambrian Geology and Palaeontology. Volume LX, numbers 4 and 5, with new genera and species of hymenoptera and microlepidoptera, respectively, from Panama.

NOTICE OF REMOVAL.—Owing to the rapid increase in the Manufacturing Branch of their business, Messrs. Isenthal & Company have now removed the whole of their Works and Offices to the Factory at Denzil Road, Neasden, to which address all correspondence should now be directed.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

AUGUST, 1912.

THE INDIAN EARTHQUAKE OF 1905.

By CHARLES DAVISON, Sc.D., F.G.S.

Twice within eight years the Indian Empire has been visited by a destructive earthquake. On June 12th, 1897, one of the greatest disturbances of modern times, if not of all time, occurred in Assam and Northern Bengal. The shock was felt over an area half the size of Europe. Within a district twice as large as Great Britain, buildings were seriously damaged. In one that equalled the whole of Scotland, no house of brick or stone could withstand the violence of the shock. Even the form of the earth's crust was changed. Yet the loss of life was small—the total number of deaths was less than two thousand—for the earthquake occurred late in the afternoon, when the people generally were at work in the open air.

The more recent earthquake, which took place on April 4th, 1905, originated in the Kangra district of the north-western Himalayas. The area affected by it differed but little in magnitude from that disturbed in 1897, but the shock was far inferior in strength. Houses were damaged over a district only a little more than half the size of Yorkshire, complete destruction prevailed over an area not much larger than the county of Rutland. The earthquake, however, occurred shortly after six in the morning, before the general hour of rising, and consequently in the central districts the loss of life was serious. As the number of persons killed was more than eighteen thousand, the Kangra earthquake, though overshadowed by the catastrophe of Messina, must be regarded as one of the great disasters of the world.

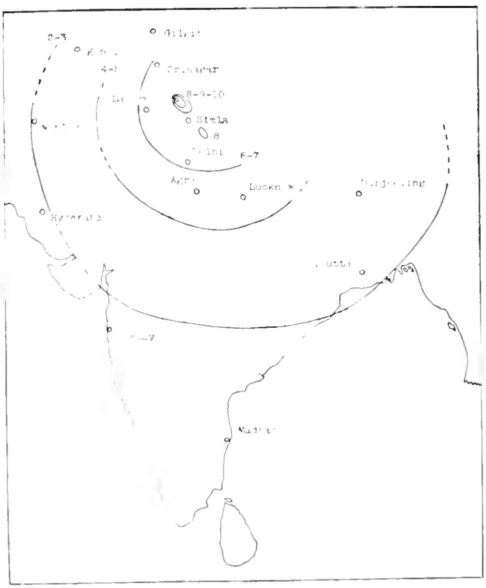


Figure 325.
The Area disturbed by the Earthquake.

We are indebted to Mr. C. S. Middlemiss, superintendent of the Geological Survey of India, for a detailed, if somewhat belated, account of this important shock. As soon as the extent of the disaster was known—and two days elapsed before it was fully realised—telegraphic instructions were issued to all officials in the area concerned to record in writing the exact time and other details of the shock. Letters were sent to the principal newspapers all over India, and forms of questions were distributed among the political officers and residents of native states. Of still greater service was the personal inspection of the central district made by Mr. Middlemiss and three other officers of the Geological Survey. They collected many details from survivors, and examined the more durable effects of the shock on the ruined towns and villages.

The loss of life, as already noticed, was in great part due to the early hour at which the earthquake occurred. But there was another contributing cause—the sudden onset of the shock. It was at first supposed that no sounds or tremors heralded the coming disaster. Further inquiry showed that during the previous thirty hours, a few weak shocks were observed. There was nothing, however, to distinguish them from others which might occur alone. They attracted little, if any, notice, and in all probability they would have passed unrecorded had it not been for their disastrous successor. Practically, this broke without warning on the central area. The initial tremors must have been brief, for the death-rate at Kangra and Dharmsala was unusually high. From single-storeyed barracks and bazaars, the able-bodied had time to save themselves. From loftier dwellings, at least ten seconds, as Mr. Middlemiss estimates, would be required for escape. Yet even this brief interval was not vouchsafed their inhabitants. They had time to move, but not to escape, before the shock attained its full strength. In the Ghurka barracks at Dharmsala, in which one hundred and thirty-five men were killed, there were hardly any who had not left their beds.

The area disturbed by the earthquake is shown in the sketch map given in Figure 325. The curves are isoseismal lines—lines of equal strength of shock. It was found possible to draw six of these lines, the intensity of the shock being estimated by means of an arbitrary standard known as the Rossi-Forel scale. Near the central area the data are numerous, owing to the personal survey made by Mr. Middlemiss and his colleagues, and the map contains isoseismal lines corresponding to each of the three highest degrees of the intensity-scale. Outside the isoseismal line of intensity 8, the records were more scanty. They were furnished by persons who answered the inquiries in newspapers or filled in the earthquake-forms, and they depend on the personal impressions of observers, not on the more or less permanent effects of the shock. In drawing the isoseismal lines, it was found necessary to group together records of intensities 7 and 6, 5 and 4, and 3 and 2. All three outer lines are, however, incomplete. They traverse territory from which no observations were forthcoming. The outermost line of all includes the whole area within which the shock was sensible to persons at rest. If we imagine it completed in the course which its last observed trends seem to indicate, it includes an elliptical area about one thousand six hundred and fifty miles long, extending from Quetta on the west to beyond Calcutta on the east, and about one thousand five hundred miles from north to south. The total disturbed area, including the portion from which records are unobtainable, therefore falls but little short of two million square miles.

Of greater interest are the three inner isoseismal lines, the course of which it was possible to delineate with some approach to accuracy. These are shown on a larger scale in Figure 326. The innermost isoseismal of the three, includes an area of about two hundred square miles. Within it are such places as Kangra and Dharmsala, in which the destruction to life and property was sweeping. Only the strongest buildings, such as the Dharmsala magazine and treasury, were able to withstand the shock; ordinary houses were not only destroyed, they were reduced to flattened heaps of debris. The next isoseismal (No. 9) encloses the area of moderate destruction. Towns and villages were ruined, but not totally. A few well-built bungalows could afterwards be used in part as shelters, a room or verandah being here and there left standing. Others could be repaired by the renewal of portions of the walls and roofs. The difference between the two zones was very marked; in the former one wandered over the prostrate ruins of houses, in the latter between fragments of partly-standing walls.

Still less disastrous were the effects of the shock within the next isoseismal, that of intensity 8. Approaching it from the outside, sensible damage to buildings began to be plainly visible; but the damage was generally slight. It amounted to little more that a fallen roof or wall or a bulging tower, damage that was so easily repaired that the inhabitants soon returned to their houses. The most remarkable feature of the isoseismal is its division into two detached portions, between which the intensity of the shock was manifestly less. The larger portion surrounds the isoseismals 9 and 10 the smaller includes Dehra Dun, Mussoorie and other places. The centres of the two curves are about one hundred and twenty miles apart in a north-west and south-east line, while the longer axes of the curves are roughly parallel.

The rate of decline in intensity in various directions from the central area is clearly shown by the form and relative positions of the isoseismal lines. These curves also bound areas within which the nature of the shock distinctly varied. From within the central isoseismal, it was found difficult to collect any personal observations. Nearly half of the inhabitants were crushed beneath fallen buildings, the majority of the survivors were unnerved by terror. The few records available show, however, that the shock was very different from that usually experienced during earthquakes. At Dharmsala there were a few gentle tremors, followed by two or three severe shocks, the second of which was the most disastrous. So far as can be judged from the personal evidence, the shocks consisted of "a mass movement in a horizontal direction and back again—not so much a fierce shaking as a drag of the ground in one direction and then in another like the wash and back-wash of a wave on shore." In the words of one observer, "the houses arched forward with violence and came down as if made of cards."

In the next zone, that between the isoseismals 10 and 9, the nature of the earthquake changed to a single forward thrust. There appears to have been no preliminary tremors, but simply one great vibration, which increased in violence to a maximum and then died down. The earth is said to have moved in waves, while trees swayed to within a few feet of the ground, and it was difficult for anyone to stand upright. The duration of the shock, as taken by a stopwatch, was one and a quarter minutes.

In the detached portion of the isoseismal 8, which includes Dehra Dun and Mussoorie, the shocks were of the usual vibratory character. They began with tremors or quiverings lasting for several seconds, like those caused by a dog scratching itself under the bed. Then came a pause of a few seconds, followed by two or three violent oscillations or groups of stronger vibrations, the whole lasting for one or two minutes. That the shock was still strong is evident from such descriptions as "an irregular motion, the observer being jerked from side to side, and then all round" or "as if taken by the shoulders and shaken violently." Persons were unable to stand or walk properly, trees swayed and tents rocked as if in a gale. Then the shocks died away gradually as they had begun.

With still increasing distance, the fierceness of the shocks declined. Rapid vibrations, of three or four a second, were manifest within the next two zones, but the great oscillations of the central area were smoothed down into a slow rolling or undulating motion, such as is felt on board a steamer in a moderate sea or in an open boat at sea. By the time the earthquake reached the outermost zone of all, that in which the shock was just sensible, the quick vibrations were all quenched, there was merely a gentle rocking of beds, water in tanks swayed, and in very distant places the bubbles in the tubes of levels were seen to oscillate.

In one respect, the Kangra earthquake differed from others of equal or greater violence—there is no visible evidence whatever of deep-seated changes in the earth's crust. In such earthquakes as those of Mino-Owari (Japan) in 1891 or Assam in 1897 or California in 1906, the fractures or faults along which the originating movement took place were continued up to the surface. Along these fractures there were displacements, both vertical and horizontal. Rivers were ponded back so as to form lakes, roads and boundary-fences were severed and their shifted ends were left standing several yards apart. In places, the crust was so compressed that allotments were reduced in width. The form of the surface was changed so that distant objects, formerly hidden by intervening mountain-spurs, became visible. In the Kangra and Dehra Dun districts, there were none of these changes. "Not a single railway has recorded any damage to the track, not a single road or path has been deflected, raised or lowered, no rivers or streams have changed their courses or been temporarily dammed up except as due directly to landslips." Surface fissures of course there were in abundance in loose friable ground, but in no case did they differ from those which might be produced by a violent shaking. The distribution of damage within the central areas is also uniform; there is no tendency to grouping along lines of exceptional destruction.

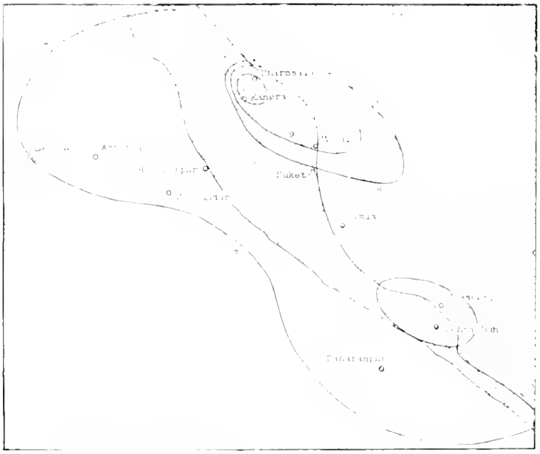


Figure 326. Isoseismal Lines.

All this seems to indicate that the focus of the earthquake was unusually deep-seated. How great the depth was we have no sure means of ascertaining. Mr. Middlemiss has endeavoured to form an estimate by employing a method which Major Dutton devised in his investigation of the Charleston earthquake of 1886. According to this method, the depth of the focus is about one and three-quarter times the distance of the region in which the intensity of the shock varies most rapidly from that which lies vertically above the focus. The method, if correct in principle, would be difficult to apply. The intensity of the shock is subject to so many abrupt variations that it is hardly possible to locate the band in which the rate of change is greatest. Moreover, the method takes no account of the loss of energy, as the waves traverse the superficial layers of the crust. We cannot, therefore, feel much confidence in Mr. Middlemiss' estimate that, in the neighbourhood of Kangra and Dharmsala, the depth of the focus must be between twelve and twenty-one miles, while, about fifty miles farther to the east-south-east, it must be between about twenty-one and forty miles. All that we can feel sure of is that the depth of the focus was considerable, and that the movements within it which caused the earthquake died out practically before reaching the surface.

In the absence of crustal deformation, it would be too much to expect that a re-survey of the central districts would show any appreciable change of level, and, if any could be detected, the district which includes Dehra Dun and Mussoorie would naturally show less than that which includes Kangra and Dharmsala. Unfortunately it is only for the former district that any previously-made line of levels is available. In 1862 the line from Saharanpur, through Dehra Dun, to Mussoorie was levelled. In 1904, less than a year before the earthquake, the portion from Dehra Dun to Mussoorie was repeated, and again a year later, or about a month after the earthquake. The last operation showed that either Dehra Dun had risen about five inches with respect to Mussoorie or that Mussoorie had sunk the same amount with reference to Dehra Dun. There may also have been movements of both places. A fresh series of levels was, therefore, carried out along the whole line from Saharanpur to Mussoorie in the cold weather of 1906-7. These corroborated the work of 1905, and proved that Dehra Dun had risen about five inches, that is, regarding the height of Saharanpur as fixed, while the position of Mussoorie was almost unchanged. The amount is a small one, but every precaution to avoid error was taken, and, as the change occurred between May, 1904, and May, 1905, it seems reasonable to conclude that one result of the deep-seated movements which caused the earthquake was this very slight buckling upwards of the crust.

The nature of these deep-seated movements is obscured both by the absence of crust-deformations and by the want of precise observations in the central area. They appear, however, to have taken place within two detached regions, one below Kangra and Dharmsala and stretching in an east-south-east direction for fifty miles or more, the other, below Dehra Dun and Mussoorie, of much inferior length. The axes of the two detached isoseismals being roughly parallel, it may be inferred that the foci were also elongated in the same direction, though not in the same line. The total length of the complex focus, including the break in the neighbourhood of Simla, must have been about one hundred and fifty miles. Throughout its whole extent the disturbance must have taken place almost simultaneously. Had it been otherwise, two great shocks would have been felt at Dehra Dun, one coming from the focus below, the other from the more important focus near Kangra. There may, however, have been an interval, amounting to a considerable fraction of a minute, between the disturbances in the two foci, that in the Dehra Dun focus being precipitated by the increased strain brought into action by the movement within the Kangra focus.

Though we cannot picture the movements which caused the Kangra earthquake so clearly as in the case of the San Francisco earthquake of the following year, the earthquake certainly belongs to the great class of tectonic shocks, those which are the result of the moulding operations that still take place within the Earth's crust. The nature of the shock within the greater central area, where it was manifested as a shift rather than as a vibratory movement, points to an actual displacement of the surface-crust, even though no permanent trace of it was left. There can be little doubt that the displacement was the last of those movements which culminated in the uplifting and growth of the Himalayas. This great range runs in an even circular arc, with its convexity towards the south. The Kangra earthquake occurred in the part where strong shocks are most frequent in such ranges, namely, on the convex steeply-sloping side.

Mr. Middlemiss points out a remarkable relation between the two foci and the geological structure of the district. The principal features of this structure are represented in the sketch-map (Figure 326). The area indicated by diagonal shading is occupied by the old Himalayan rocks. Bounding it on the south-west is a band, shown by dotted shading, consisting of the younger Tertiary formation of the Sub-Himalaya. To the south-west of this, again, the whole region is covered with alluvium. Between the Tertiary rocks of the Sub-Himalaya and the older Himalayan formations, there runs a great boundary-fault, which, just to the north of Dharmsala, bends rather sharply to the east, and, after sweeping in a great curve round the foot of the Simla mountain spurs, returns to its normal direction. This direction is maintained until near Mussoorie, when it again bends to the east, sweeps round in the same way as before, past Dehra Dun, but in a smaller curve, after which it once more resumes its normal direction. "Nowhere else along the Himalayan mountain-foot, as we know it," says Mr. Middlemiss, "is there such exceptional irregularity, unevenness one might say, in the disposition of these bordering bands of Tertiary strata."

Now, as will be seen from Figure 326, the two earthquake centres lie in the Sub-Himalayan band, nearly but not quite along the line of the great boundary-fault, and precisely in those parts where the band widens and invades the older Himalayan mass. Moreover, the main centre lies in the larger bay, and the secondary centre in the smaller. Mr. Middlemiss further notices that the regions occupied by the earthquake centres are both "regions of reversed faulting, where a packing of the strata and an overriding of the younger by the older rock series is specially prominent. They coincide with parts of those regions where there is irregularity in that packing, and where the regular marginal arc of the mountain, as expressed in the parallel earth folds and faults, is interrupted."

The place of the Kangra earthquake among other destructive shocks is not easy to determine. Loss of life and injury to property are fallacious guides. The one depends on the time at which the shock occurs, the other on the construction of the buildings and the nature of the materials employed.

If we were to measure the strength by the area disturbed, the Kangra earthquake would have to be regarded as among the greatest of all recorded earthquakes, as superior to the Japanese earthquake of 1891, as roughly equal to the Assam earthquake of 1897, yet as inferior to the much less disastrous earthquake of Charleston in 1886. The extent of the area of complete destruction is a more trustworthy standard. Measured in this way, the Kangra earthquake falls far short of the Assam earthquake of 1897. The most satisfactory test of all, however, is the intensity of the shock within the central area, but this is known precisely in the case of only a few recent earthquakes. At Dharmsala, the shock was distinctly stronger than the Californian earthquake at San Francisco in 1906 or the Calabro-Sicilian earthquake at Messina in 1908. At Kangra it was nearly twice as strong as at either of these places. But, even at Kangra, the intensity was less than that of the Japanese earthquake of 1891 in the Mino-Owari plain, and was not to be compared with that of the same earthquake in the crushed and distorted rocks of the Neo Valley.

In its destructive effects, the Kangra earthquake reiterates the lesson which governments are so slow in learning. Thickness of wall alone is no safeguard: it may be a source of weakness. With inferior material and no frame-bindings, such a mass is at once shattered by an earthquake shock, as in the barracks at Dharmsala, where many Ghurka soldiers were killed and wounded. In the Kangra valley, ordinary buildings had walls of mud or rubble masonry surmounted by a heavy slate roof. Few structures could offer less resistance to an earthquake, the result being that more than a hundred thousand houses were destroyed in Kangra and the surrounding country. Mr. Middlemiss considers that it would be useless to urge the construction of earthquake-proof houses or to discountenance building on ridges or mountain-spurs. Disastrous earthquakes, he remarks, are isolated occurrences, and it is economical to make use of materials close at hand, and convenient to follow familiar styles of building. But the government that urged such reasons for inaction might with equal justice neglect to insure their property against fire, or to prepare for a foreign war.

THE OPTICAL CONVENTION, 1912.

This convention was held in the Science Museum, South Kensington, from June 19th to the 26th, under the presidency of Professor Silvanus P. Thompson, D.Sc., F.R.S.

The objects of the conference were to investigate how theory can further industrial development, and how practical problems may direct theoretical investigation; to discuss the better organisation of the British optical industry, and the improvement of British optical manufactures; and to ascertain and make known existing wants and deficiencies. The exhibition held in connection with the conference was designed to show the resources of British manufacturers of optical appliances.

Messrs. Reynolds & Branson, Ltd., exhibited a special adjustable front stage for the Stroud & Rendell optical lantern, which enables an ordinary microscope, with the eyepiece removed, to be used for projection.

A new type of sunshine recorder was shown by the Cambridge Scientific Instrument Company—Callendar's Bolometric Sunshine Receiver. This consists of two platinum resistances mounted on a mica framework, hermetically sealed up in a glass bulb filled with dry air. One of the resistances is blackened, the other is left bright The two are connected in the opposite arms of a recording Wheatstone Bridge. When radiant heat falls on the receiver, the blackened resistance absorbs more heat than the other, its temperature rises and the recorder is thrown out of balance. On the usual clock-driven drum these variations are marked, indicating not only the number of hours of sunshine, but also the intensity of the radiation in absolute units.

The same firm also showed an improved form of Thomson Galvanometer invented by Professor Paschen, which is many times more sensitive than the normal form.

Mr. R. W. Munro has designed an anemograph which records, on a single chart, wind pressure, as well as direction and time. This should replace the expensive double instrument at present employed.

Messrs. Raphaels, Ltd., have evolved handy instruments for measuring any muscular imbalance of the eyes in the Maddox Near Vision Phorometer and in the Micro-telescope, a useful combination of the telescope and microscope giving magnifications of 12 and 20 diameters respectively.

A very interesting loan collection was also on view, including a Star-Photograph Micrometer, many early types of microscopes, a camera lucida formerly belonging to Dr. Wollaston, a little Dumpy Reflector Telescope made by James Watson in 1794 of very perfect figure with both Gregorian and Cassegrain, an original Nicol Prism by William Nicol and one of Fraunhofer's prisms.

The catalogue will be useful as a record of the various types of instruments made by British manufacturers in the different branches of optical science.

H. H. P.

Among the papers read at the recent Optical Convention there are some which are of considerable interest to the general public, who are not, as a rule, concerned with the manufacture or use of optical instruments other than the eye and spectacles. Dr. M. von Rohr, of the Zeiss works at Jena, dealt with the form of spectacle lenses designed to give a field of "direct vision": in other words to enable the wearer of the glasses to transfer his gaze from one object to another by simply rolling his eyes without moving his head, and this without any loss of distinctness of vision. Another paper by Messrs. Dow and Mackinney on "Some Recent Advances in the measurement of light and illumination" describes some methods which should help to popularize such measurements. Thus, in choosing a wallpaper for the drawing room, we should not allow ourselves to be content with a surface brightness of less than 0·3 foot candles. For the library or the dining room we may be prepared to accept very much less than this. If we provide ourselves with a holophane lumeter and a celluloid test-card, we can easily discover whether the samples of wallpapers submitted to us by the builder come up to our standard. A paper on the design and construction of large Polariscopes by Professors Coker and S. P. Thompson, will be of interest to those who saw, at a recent Soirée of the Royal Society, the wonderful double-refracting effects produced by varying stresses in certain celluloid models. A paper on errors of observation by Messrs. Baker and Bryan will be of interest to naval officers and all who make use of the sextant and prismatic compass.

W. D. L.

IS MATTER INDESTRUCTIBLE?

By H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S.

When a candle burns it ceases to exist as such. Closer examination of the phenomenon, however, shows that this is not all that occurs. Not only does the candle disappear, but some of one of the constituents (oxygen) of the atmosphere is used up; and in the place of the candle and oxygen, new gases (carbon-dioxide and water-vapour) make their appearance. If all these bodies are carefully weighed at the same spot on or above the earth's surface, it will be found that the combined weights of the carbon-dioxide and the water produced are exactly equal to the combined weights of the candle and oxygen consumed. A similar statement holds good of every other chemical change; the combined weights of all the bodies produced during such a change is always found to be exactly equal to the combined weights of all the bodies consumed.

Now, the weight of a body is the force by which it is attracted to the earth's centre; thus, the force pulling a two-pound weight to the earth's centre is twice that acting on a one-pound weight at the same place. Force is sometimes defined as that which produces or tends to produce motion. It appears, however, that force is one of man's primary conceptions, and as such, is undefinable, since the idea of force cannot be resolved into simpler ideas; but even as a description of force or of its effects the above statement is not altogether satisfactory. In order to keep a body moving with uniform velocity over a rough surface, force must be continually applied to it. But this force is needed to overcome friction, itself a force which constantly tends to decrease the rate of the body's motion—that is, to impart to it a retardation or negative acceleration. If more force than that required to overcome friction is constantly applied to the body, it will move with ever-increasing velocity that is to say, the force will impart acceleration to the body. Moreover, with the reduction of friction by any means, such as by the use of a lubricant or by replacing the rough surface by a smooth one, less force is needed to keep the body moving with a given uniform velocity. The conclusion is justified, therefore, that could a perfectly smooth body be procured, no force would be needed to keep it moving with uniform velocity over a perfectly smooth surface; though force would be needed to *start* the body so moving—that is, to impart the acceleration to the body necessary to increase its velocity from zero to that velocity with which it is required to move. It follows, therefore, that force may be more accurately described than by the definition already given as that which produces or tends to produce acceleration (either positive or negative), or what is the same thing, *change* of motion.

If no forces whatever are operative on a body, it will remain in a state either of rest or of uniform motion; to change this state force is necessary. This fact is expressed by saying that the body possesses *inertia*. Inertia may, therefore, be defined as that property of a body in virtue of which it tends to keep in a state either of rest or of uniform motion, and will remain in this state unless and in so far as force is applied to it. Now, in order to produce a given acceleration (or change of state of rest or uniform motion) in different bodies, experiment shows that different forces are necessary. Thus, in order to accelerate two pounds of iron one foot per second per second (that is, to increase its velocity one foot per second every second), twice as much force is necessary as is needed to accelerate one pound of iron one foot per second per second. This fact is expressed by saying that the inertia of two pounds of iron is twice that of one pound of iron. That is to say, the inertias of bodies may be measured by applying to them (for the same period of time in each case) such forces as are necessary to impart to them a given acceleration; the forces applied will then be proportional to the inertias of the bodies.

Now, if various bodies are dropped from the same heights above the earth's centre, and if the friction due to the air is obviated, by using a vacuum or otherwise—that is to say, if various bodies are allowed to move under the influence only of their respective weights—it will be found that they will all fall with the same constant acceleration, no matter what their size, shape or weight may be.* This acceleration is called *g*, and is, approximately, thirty-two feet per second per second. Since the only force operative on each body is its weight, and since the acceleration is in all cases the same, it follows that the weights of bodies determined at the same point relative to the centre of the earth are proportional to their inertias.

It has already been pointed out that the sum of the weights of all the bodies produced by a chemical change is exactly equal to the sum of the weights of all the bodies consumed therein, so long as all the weights are determined at the same place on or above the earth's surface. If in place of "weights" in this statement the word "inertias" is substituted, the reservation may be deleted, and the inductive law may be formulated that chemical action has no

* This may be demonstrated by means of the following very simple experiment. Place a small piece of paper on top of a penny (the paper must be smaller than the coin); allow them to fall together; the result will be that they will both reach the ground at the same time. The reason for placing the paper on top of the coin is that by this means the paper is protected from the retarding influence of the air, which is much greater in the case of the paper than it is in that of the coin.

effect upon inertia. This is the law of the conservation of inertia.

This law is very frequently termed the law of the conservation of mass. It used to be known as the law of the conservation or indestructibility of matter, and this expression is still occasionally met with. The first of these expressions is objectionable because, although "mass" is generally used by modern physicists in the sense of "inertia" as defined above, at one time it was held to signify the "quantity of matter in a body." "Mass," therefore, is an ambiguous term, and ought to be avoided, since the word "inertia" accurately expresses its modern connotation without ambiguity.*

With the second of the above expressions we have now to deal. The word "matter" is exceedingly ambiguous.[†] By a certain school of metaphysicians, who may be termed materialists, the word "matter" is used to denote a hypothetical thing-in-itself, a "substance" supposed to underlie all the phenomena of the physical universe. This metaphysical use of the word at once places it outside the domain of pure science, since science is only concerned with phenomena as such. It is, of course, obvious that the law of the conservation of inertia affords no ground for asserting the indestructibility of matter so defined. According to the materialistic hypothesis, matter is known to us not only by its inertia, but by all those other phenomena which are termed (in accordance with this hypothesis, and loosely by those who do not hold it) "properties of matter." Surely, then, the "quantity of matter" in a body is not to be measured merely by the inertia of the body, but rather by the sum of all its "properties." The argument that the "quantity of matter" must be measured only by the inertia, since all the other "properties" of a closed material system are variable, the inertia of such alone being constant, is a flagrant *petitio principii*, since it assumes the very point at issue, namely, the indestructibility of matter. Indeed, since materialistic philosophers always postulate *extension*, or the property of occupying space, as the most fundamental "property of matter," it would seem that the "quantity of matter" in a body ought to be measured, if by one "property" alone, by its *volume*: and the volume of a body is by no means constant. The volume of bodies, as is well known, can readily be altered merely by the application of pressure or by a change in temperature; moreover, the volume of a reacting system is not usually constant during a chemical change.

By another, and less speculative, school of philosophers the term "matter" is used merely to connote the fact or, perhaps we should say, law that certain phenomena (the so-called "properties of matter") are always found grouped together so as to form a complex, which may be termed a "material body"; and it is now becoming more completely realised that the term "matter" ought to be employed in purely scientific writings only with some non-metaphysical meaning such as this. If the term is used in this sense, there is evidently no justification for supposing that matter is indestructible because inertia is conserved. For, thus employed, "matter" stands for many phenomena, or "properties," or rather for the fact or law of their connection; not merely for that particular phenomena or property termed "inertia."

No alleged scientific evidence has ever been brought forward in favour of the doctrine of the indestructibility of matter, save the facts generalised under the expression "the law of the conservation of inertia." Now it is evident that these facts can only be regarded as evidence of the truth of this doctrine, if it can be proved that the matter of a body (in whatever sense the word "matter" is used) is identical with, or measured by, the inertia of the body. Nothing, however, has ever been advanced to prove this, and as must be evident from what has been already said, it is most unlikely that any such relation between matter and inertia holds good. Moreover, if it were maintained that "matter" ought to be defined as "inertia," the obvious reply is that this would be contrary, not only to the ordinary usage of the word, but also to its use by philosophical writers generally.

But to consider even unlikely possibilities, were it proved that the inertia of a body does, in fact, measure the "quantity of matter" it contains, or were it generally agreed that the word "matter" ought to be employed as synonymous with "inertia," the case for the doctrine of the indestructibility of matter would in no way be improved. For Professor Sir J. J. Thomson has proved mathematically that an electrically-charged particle in motion possesses inertia in virtue of this motion, and that if its velocity is sufficiently high, an increase in the velocity produces a considerable increase in its inertia. This has been experimentally verified by Kaufmann, who measured the inertias and velocities of the small particles emitted by the disruption of the atoms of radium. He found that the greater the velocities of these particles the greater were their inertias, the observed increment in every case agreeing with that calculated according to Thomson's reasoning. It is evident, therefore, that although inertia is conserved during chemical action, the inertia of an electrically-charged body may be altered by sufficiently accelerating it. If then, "matter" is the same thing as inertia, or is measured thereby, it is evident that matter may be created by sufficiently accelerating such a body, or destroyed by retarding it.

* For a further discussion of the ambiguity of the word "mass," and its bearing on the philosophical doctrine of materialism, see the chapter "On the Indestructibility of Matter" in the present writer's "Matter, Spirit, and the Cosmos" (Rider, 1910).

† Compare Professor Ostwald's remarks on the use of the word "matter" in his "The Fundamental Principles of Chemistry" (trans. by H. W. Morse, 1909), §§ 7 and 10.

It is evident, therefore, that, at the best, the doctrine of the indestructibility of matter is a pure hypothesis, entirely unsupported by scientific evidence: indeed, so far as we can see, contradicted thereby. This fact is very generally recognised by physicists now-a-days*, but many people still believe that the doctrine of the indestructibility of matter is a law of the highest scientific importance, supported by the most convincing evidence. It is nothing of the sort. The expression "law of the indestructibility of matter" does figure largely in old scientific text books, but it is quite a mistake to suppose that this so-called "law" is one of the foundation-stones of modern science. The law of the conservation of inertia, which is true under all but the most exceptional conditions, and which is a generalised statement of observed facts involving nothing hypothetical, suffices for all the purposes of the natural sciences for which the hypothetical "law of the indestructibility of matter" was at one time employed.

* Cf. Professor H. C. Jones, "The Elements of Physical Chemistry" (1902), p. 2.

EVERYMAN'S ASTRONOMY.

By Dr. ALFRED GRADENWITZ.

More and more attention is paid to astronomical instruction in the curriculum of grammar schools, and some German "Gymnasia" have even gone so far as to install observatories of their own. As, on the other hand, the number of amateur astronomers is rapidly increasing, there is obviously a need for designing special instruments for lay people which, while warranting a sufficient degree of accuracy, may enable anybody without mathematical calculation to get a clear insight into the topography of the heavens.

FIGURE 326.

The New Star Finder.

A German instrument maker, F. Sartorius, of Göttingen, has designed a "star-finder," an astronomical instrument of surprising simplicity and remarkable precision, which enables any layman to ascertain the name of any star observed in the sky and the constellation to which it belongs or, inversely, to find out any given star from its name and position. Its design is based on the following considerations:

The position of a star in the sky is known to be defined by two angles, *viz.*, rectascension and declination, corresponding to the geographical longitude and latitude respectively of points on the globe. Again, orientation in the sky, the same as on the earth, should be based on the North-South direction of the magnetic needle. This is why the star-finder primarily comprises a compass.

The star-map which forms an indispensable part of any instrument of this kind, should be adjustable parallel to the equator which serves as basis in determining the latitude and longitude. The horizontal position of the axis round which the star map is free to rotate, therefore, is ascertained by a level, and a graduated circle allows the map to be adjusted to the geographical latitude of any given locality. Now, all stars and constellations in their apparent twenty-four hours' revolution, due to the rotation of the earth, are known to advance each hour an always constant distance, their angle with regard to the initial meridian changing progressively. On the other hand, on account of the revolution of the Earth round the Sun, the point of the sky which at noon or at midnight occupies the highest position or passes through the meridian, advances about one degree (360/365) in a western direction: that is to say that the stars in their turn perform a progressive motion from East to West.

These principles are utilized so cleverly in the star-finder that a few manipulations, without any mathematical calculation, suffice to find out any star desired.

Round the centre of the star-map there are free to turn two rectangular arms, one of which carries at its end the graduated declination circle. On this circle rotates a diopter, which is pointed towards the star and which by its position on the graduated circle, immediately indicates the declination of the former. The rectangular arm carries, at right angles to the diopter axle, a disc, which in its turn, on the inside hours' gradnation of the star-map, indicates the rectascension of the star. The gradnation of this disc agrees with that of the declination circle, so that the star towards which the instrument is pointed is read directly below the division of the graduated disc marked by the diopter on the declination disc.

The inside hours' graduation is surrounded by another dial (diurnal and monthly), which in its turn is adjusted with regard to the fixed outside hours' graduation. This allows the star-map to follow the apparent progression of stars, the hourly advance being continually accounted for.

THE CANADIAN RUFFED GROUSE.

By CHARLES MACNAMARA.

The Canadian Ruffed Grouse (*Bonasa umbellus togata*), popularly known as the "partridge," is one of our most widely-distributed game birds, being found wherever there are woods, from New Brunswick to British Columbia, and as far north as Hudson's Bay. It is a handsome grayish bird of markedly gallinaceous appearance, some seventeen inches long and of stout build. The extraordinary "drumming" noise made by the male bird to call the female is familiar to everyone who frequents the woods in the spring. To produce this remarkable sound the bird stands on some slight elevation, such as a log or a stone, and strikes the air strongly with his outstretched wings. The first four or five strokes, occurring at intervals of about half a second, sound like blows on a rather dull bass drum, but they rapidly get faster and faster until the sound becomes continuous like the roll of a snare drum. The whole performance lasts, perhaps, ten seconds, and is repeated every few minutes for some time.

In the northern part of its range this bird has another peculiar habit: that of tunnelling into a snowdrift for protection against the intense cold. In order to begin its tunnel it sometimes walks around, deliberately burrowing here and there into the snow with its head until it finds a suitable place, but its general procedure is to dive from an elevated branch or directly off the wing into the drift, the momentum of its plunge being sufficient to drive it some little way into the soft snow, and thus enable it to start its tunnel conveniently. Then, at a depth of three or four inches under the surface, it scratches out a horizontal or slightly descending passage about two feet long, the end of which it enlarges into a roughly spherical chamber eight or ten inches in diameter, the removed snow completely blocking up the entrance tunnel. Here the bird, apparently preferring hunger to cold, may spend several days if the weather is severe. Except for the one mark where the tunnel begins, the surface of the snow is quite undisturbed, and no one would ever suspect that a live warm bird was concealed in the drift. To leave its burrow, the bird simply bursts out through the overlying layer of snow, springing into immediate flight.

FIGURE 328.

The Snow Burrow of the Canadian Ruffed Grouse.

At the lower right hand corner is the entrance to the burrow. In this instance, the roof of the tunnel has sunk slightly, so that its course can be traced on the surface. The hole to the upper left hand is the terminal chamber, out of which the bird has burst. The mark of its wing can be seen on the snow to the right of the hole.

FIGURE 327.

The Canadian Ruffed Grouse (*Bonasa umbellus togata*).

One day last January, when the thermometer stood 10° below zero F., I stopped a moment while snowshoeing through the woods to examine a curious isolated mark on the snow. At that instant a "partridge" burst out just at the toes of my snowshoes, and with a great whirr of wings disappeared among the spruces. The mark I had noticed was the entrance to the tunnel, and from its appearance the bird had evidently been three or four days in its burrow, and would doubtless have remained there longer if my approach had not frightened it out. Dry soft snow is, of course, an excellent non-conductor of heat, and even in the very coldest weather, the ruffed grouse is no doubt quite comfortable in its immaculate chamber.

THE FERTILISATION OF THE FIG.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

MUCH has been written, from the time of the earliest Greek naturalists to the present day, concerning the fertilisation of the fig, but it would appear from some recent researches that the problem is by no means cleared up yet, and that the process is one of great complexity, involving one of the most astonishing examples of symbiosis, or mutual relationship between organisms, that has ever been disclosed.

The genus *Ficus* is an extensive group belonging to the family Moraceae, which includes also the mulberry, and which is related closely to the nettle and elm families. Besides the various kinds of figs, *Ficus* comprises among its six hundred species, which are chiefly indigenous to the East Indies and Polynesia, such well-known plants as the indiarubber tree, the banyan, and the peepul.

The edible fig of commerce (*Ficus carica*) appears to be native in Asia Minor and Syria, but now grows "wild" in most of the countries around the Mediterranean. Doubtless owing to the ease with which its nutritious fruit can be preserved, the fig was probably one of the earliest plants to be cultivated. According to Herodotus, the fig was unknown to the Persians in the time of the first Cyrus, but it must have spread in remote ages over all the countries around the Aegean and the Levant. Apparently the Greeks received the fig from Caria, whence the specific name, but they improved the fruit so much by cultivation that Greek figs became celebrated throughout the East. From Greece, at some prehistoric time, it was taken to Italy, where numerous varieties, mentioned by Pliny, arose under cultivation. The fig is now grown in all the Mediterranean countries, but the greater portion of our supply comes from Asia Minor, Spain, and the south of France. It was introduced into England from Italy by Cardinal Pole in the sixteenth century, and is grown for its fresh fruit in all the milder parts of Europe and the United States, though farther north it requires protection in winter and a south wall for its successful cultivation out-of-doors.

In the fig, as in other species of *Ficus*, the flowers are produced inside a hollow pear-shaped receptacle opening by a narrow pore at the top. Just below the mouth, in most species, are the male flowers, while the rest of the cavity is lined by the closely packed female flowers. The individual flowers are small and of simple structure, the male having only one or two stamens and the female a small ovary with a slender style at its apex.

It has been known for some time that the flowers of *Ficus* are fertilised by means of small wasps called *Blastophaga* and *Sycophaga*. The female wasp enters a fig and lays its eggs in the ovaries of the female flowers; this occurs at an early stage, when the stamens of the male flowers have not yet opened. The male wasps arising from these eggs fertilise the females, and as these emerge from the opening of the receptacle they are dusted with pollen from the male flowers, and carry the pollen to other inflorescences.

According to more recent investigations, however, the story of the relation between the wasp and the fig-tree is longer and more involved than this simple statement would imply. Tschirch* has recently published a memoir on the wild and cultivated figs of Italy, based chiefly upon extensive observations made by the Italian botanist Ravasini. Apparently there are three forms of *Ficus carica*—(1) the wild fig itself, (2) the male plant or Caprificus (*Ficus carica α caprificus*), and (3) the female fig (*Ficus carica β domestica*). The two cultivated forms, male and female, are varieties which have arisen from the original wild fig; the *caprificus* form, being functionally male, of course produces no seeds, while the seeds produced by the *domestica* form give rise to seedlings which revert to the wild fig.

The wild fig produces three generations or crops of inflorescences. (1) The "profichi," appearing in February or March and ripening in June, contain only male flowers and short-styled female flowers which produce no seeds, and are not edible. (2) The "fichi," appearing at the end of May on the lower parts of the branches and ripening in September, contain long-styled fertile female flowers, and are edible. (3) The "mamme," appearing in September on the young shoots and ripening in March or April of the following year, contain only the short-styled flowers producing no seeds, and are not edible. The "profichi" constitute the male generation; they remain hard and contain little or no sugar, and are usually filled with the wasps—*Blastophaga grossorum*. The "fichi" form the female generation, producing seeds and becoming fleshy and sweet. The "mamme," which remain quite small, serve only to harbour the wasps during the winter; they wither and fall off in spring when the insects have escaped.

The female wasp enters the "mamme" in autumn and deposits her eggs in the short-styled flowers, stimulating these to grow into "gall-flowers," containing a larva instead of a seed. Tschirch states that these flowers contain an undifferentiated mass of tissue instead of a normal ovule or "young seed," but according to other writers an ovule is present though it does not ripen into a normal seed; in any case, these flowers are specially adapted for the nursing of the wasp larvae, since the female wasp is able, owing to the shortness of the style surmounting the ovary, to penetrate the latter with her ovipositor

* *Berichte d. deutsch. bot. Ges.*, XXIX.

and thus successfully lay her egg in the nutritive tissue of the ovary. The young insects, male and female, arising from the eggs, remain inside the "mamme" during winter. The male wasps, which are wingless, never escape from their prison, but fertilise the females *in situ*, and in spring these females creep out of the inflorescence and enter the "profichi," the male flowers of which are not at this time mature. Here they lay hundreds of eggs in the female flowers, occupying the lower portion of the receptacle, these flowers being similar in structure to those found in the "mamme." As before, the eggs develop into females and wingless males, the latter fertilising the former, which then escape and, in creeping from the opening, rub against the male flowers produced in the upper portion of the receptacle and thus become dusted with pollen. Loaded with pollen, the female wasps, escaping in July, enter the young "fichi," where they find the female flowers ready for pollination. In the "fichi," the female flowers have a long style, hence the insect cannot reach the ovule with its ovipositor—instead of laying its egg in the ovule of these flowers, the wasp simply smears the top of the style with pollen from the male flowers of the "profichi." The "fichi" thus produce normal seeds. During summer the insects wander in and out of the "fichi," but as the inflorescence grows in size the opening at the top becomes narrowed, and eventually the female wasps desert their summer home and enter the young "mamme," so that by September they are in their winter quarters once more. This brings the strange cycle of events round to the point from which we started (see Figure 329).

Evidently man—for it can hardly have come about in a natural way—has produced from the wild fig two forms which are propagated only by cuttings, a male and a female form, both showing an incomplete life-history as compared with the original wild form. This splitting up, so to speak, of the original wild form, has obvious advantages. The wild fig has only one edible crop, while the cultivated female (*domestica*) may bear three generations of edible inflorescences, giving ripe figs nearly all the year round. Moreover, the *domestica* form produces larger and sweeter fruits, which when ripe do not contain the unappetising black wasps found in the wild fig.

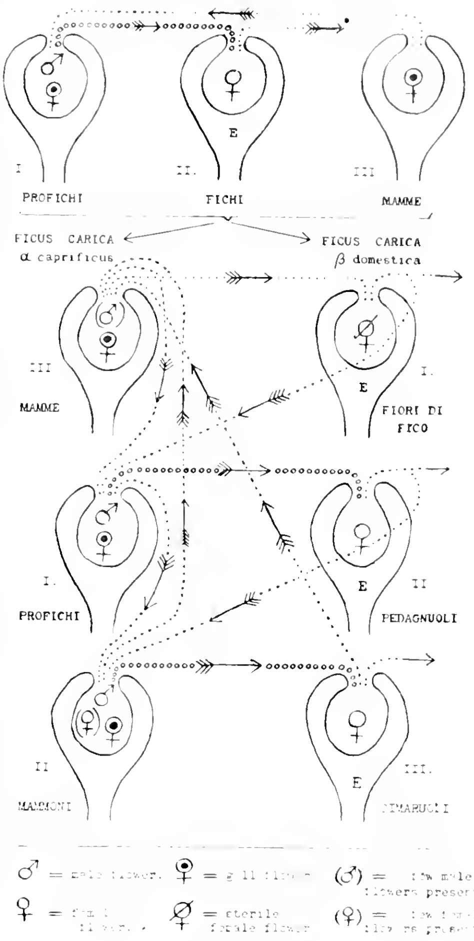


FIGURE 329.

Fertilisation of the Flowers of the Fig.

Diagram illustrating the relations between the Wild Fig and the varieties *caprificus* and *domestica*, also the migrations of the wasp (*Blastophaga grossorum*) in each of the three forms. The dotted lines indicate the ordinary paths taken by the wasp, the rows of small circles its paths when carrying pollen from one inflorescence to another. The edible inflorescences are marked E.

Ficus carica α caprificus bears typically three generations of inflorescences. The "profichi" (appearing in February or March, ripe in June and July) contain about two-thirds gall flowers and one-third male flowers. The "mammoni" (appearing in May, ripe in August or September) are similar, but contain fewer male flowers and sometimes have a few female flowers. The third generation consists of "mamme" (appearing in September, ripe in March or April), which contain gall flowers, with a very few males just below the opening, but no female flowers.

Neither of these generations in *caprificus* is edible, nor are any seeds produced. Of the three kinds, only the "profichi" come to full maturity; the other two kinds are produced in small numbers, and often fall off before reaching maturity, especially if they remain unvisited by the wasp. In fact, the *caprificus* form serves solely for the habitation of the wasp (which goes through its life-cycle here exactly as in the wild fig) and for the provision of pollen for the fertilisation of the flowers of the cultivated female fig. It is obvious that the *caprificus* form has arisen from the wild fig by suppression of the female flowers, which are in this form either absent or reduced to a very small number, hence as a rule no seeds are produced. The *caprificus* has, so to speak, split away from the parent wild form, carrying with it the male character and the completeness of the adaptation to the wasp in this form, and not in the cultivated female fig, we still have the so-called gall-flowers.

In the female fig (*Ficus carica β domestica*) there are either two or three generations, all of which are exclusively female or else sterile, and all edible; there are no male flowers or gall flowers. (1) The inflorescences of the first generation ("fiori di fico") rarely come to full maturity: most of them fall off in spring. They contain sterile female flowers, but these are not adapted to the wasp, since the style of the pistil is long and is closed up, hence if any of the insects stray in, they seek in vain to lay their eggs in these flowers. (2) In May or June appear the inflorescences of the second generation ("pedagnuoli"), and in most varieties these alone become fully ripe, maturing from August to October. These inflorescences contain normal female flowers with well-developed ovules, which are fertilised by pollen brought by the female wasp from the "profichi" inflorescences of the *caprificus*, these latter being mature at this time of year; hence the "pedagnuoli" produce ripe seeds. (3) The inflorescences of the third generation ("cimaruoli") hardly differ from the second, except that here the inflorescences are developed at the ends of the branches instead of lower down. They are produced in August and September, or even later, and in unfavourable seasons fall unripe from the tree, though in Italy these "winter-figs" are often produced in abundance. In general, the *domestica* form produces only one generation of fully-ripe fruits, usually the "pedagnuoli." In some varieties the earlier crop ("fiori di fico") ripens freely, and there are but few of the "pedagnuoli" matured in that case.

The *domestica* form has clearly arisen from the female generation ("fichi") of the wild fig, since it carries only the characters of this generation, and does not produce male flowers. The advantage of cultivating the *domestica* form, namely, the production of edible and insect-free fruits all the year round, is accompanied by the disadvantage that these fruits are relatively small. To obtain large fruits, which will remain on the tree until fully ripe, and which can be dried, fertilisation is necessary, and "caprification" is resorted to. This process, practised from ancient times, consists simply in placing branches of the wild fig or the *caprificus* (bearing "profichi") over the cultivated bushes—the wasp *Blastophaga* is sluggish of flight, hence the male inflorescences have to be brought close to the *domestica* plant in order that the wasp may carry pollen into the female inflorescences of the latter.

Besides the types *caprificus* and *domestica*, however, there are other forms of *Ficus carica* which may be regarded as reversions to the original wild fig. For instance, there is a transitional form between *Ficus carica* and *Ficus carica α caprificus*, in which the inflorescences of the first generation are of the "profichi" type, while those of the second generation have male, female and gall flowers. In another form, transitional between *Ficus carica* and *Ficus carica β domestica*, the inflorescences of the first generation have female flowers like those of the "fiori di fico," and an equal number of male flowers as in the "profichi," while those of the second generation are exclusively female.

NOTICES.

THE CLASSIFICATION OF SOILS.—Professor Elmerfitten, of Cornell University, gives in *Science* for May 3rd, a practical classification of soils. He first considers climate under the heading of "region" which is dependent upon temperature; while "section" is based on humidity. Under the heading of "province" mode of formation is discussed; the "group" occupies itself with the source of material; the subheadings of "series" are colour, organic matter, total plant-food content, while the "type" is determined by texture and structure. Altogether the article is a very suggestive one.

THE WORK OF THE IMPERIAL INSTITUTE.—*The Quarterly Bulletin* which records the progress of agriculture and industries in the colonies and India is now published by Mc. John Murray. The first number of Volume X is before us; it contains a number of important papers which are the results of investigations made at the Imperial Institute. They deal with such subjects as the rubber and timber resources of Uganda and cotton soils of Nyasaland, which are of technical interest, but there is much which will appeal to the general reader in the notices respecting economic products. Included are notes on the commercial uses of the cocoanut as well as the cultivation of hemp and of ginger. Allusion may also be made to the general notes, which will particularly appeal to botanists.

THE ALTERATION OF CHEQUES.—Mr. William Kinsley, who is an examiner and photographer of questioned documents, sends some interesting reprints of articles which he has written. One dealing with the alteration of cheques describes a case in which a twelve dollar draft had been so carefully altered that it required careful examination under the microscope to detect what had been done. The cheque had been perforated but the holes had been carefully filled up with paper pulp and new ones made, and the surface of the safety tint paper, after the erasure of "twelve," the old amount and the filling in of "twenty-two thousand" the new, had been restored by means of water-colour.

CHLORINE FOR THE TEREDO.—*The Scientific American* for May 4th, describes a means of killing the boring mollusc known as the Ship-worm or Teredo by means of breaking up sea water by electricity, so that chlorine gas is liberated in the neighbourhood of the submerged timber of wharfs. Electrodes are suspended in the water and the power plant is on a barge. The current is turned on for about an hour and the operation is timed so that the action of the tide will help rather than hinder the process of chlorination. The electrolytic treatment must, of course, be repeated from time to time.

THE SUBTLETY OF LIFE.

By MARGARET R. THOMSON.

It has long been a matter of common knowledge that certain organic poisons which gain an entrance, by some means or other, into the human body, have the effect, when once overcome by their victim, of rendering him invulnerable, or "immune," so far as that particular poison is concerned, usually for the rest of his lifetime. Familiar instances are the poisons produced by certain common infectious diseases, measles, whooping-cough, scarlet fever and the like, one attack of which, in the majority of cases, has the effect of protecting from subsequent attacks. It is on this fact of immunisation that vaccination as a preventive for smallpox is based, and the knowledge of it led Pasteur to his wonderful results in the treatment of rabies and in the "taming" of the deadly anthrax bacillus.

Equally familiar is the fact that there are poisons which render the individual increasingly tolerant of them if their use is persisted in. Thus, the confirmed opium-taker can imbibe or inject a dose which would certainly be fatal to a normal individual, and which would have been fatal to himself had he not accustomed himself to gradually increasing quantities. De Quincey, in his "Confessions," tells us that he gave to a wandering Malay who came to his door, a piece of opium large enough to kill six dragoons and their horses if they were not trained to it. The Malay received it with delight, broke it into three pieces, and immediately swallowed them all. De Quincey's own allowance at one period of his life was eight thousand drops of laudanum a day.

Within the last seven or eight years a new aspect of the effect of poisons has come into prominence. Certain poisons when introduced into the circulation increase, sometimes to an enormous extent, the susceptibility of the individual to the toxic action of that particular substance. This fact was apparently not unknown to some of the earlier physiologists, though it was not adequately described, and its importance was not recognised. For all practical purposes the phenomenon was discovered in 1902 by the eminent French physiologist, Professor Ch. Richet, and he it was who coined for it the name Anaphylaxis,—a companion word to prophylaxis or protection against disease.

In a recent number of a French journal, Professor Richet himself describes the way in which he was led to the discovery, and in the second edition of his book* summarises the facts that have been collected, and describes the experiments that have been made by himself and by other physiologists in various countries who have devoted their attention to the subject.

In the course of a series of experiments with the poison from the "stinging cells" in the tentacle of *Actinia*, one of the common sea-anemones, Professor Richet soaked portions of the tentacles in glycerine, and injected the solution of the poison obtained into the veins of a dog. He found to his great surprise that, while for a fresh subject a fairly large dose was required to cause death, a dog which had been treated with the poison about a month previously and had fully recovered his condition, quickly succumbed to a dose of about one-twentieth the original strength. That the poison was cumulative in its effect was the most obvious explanation, but the smallness of the dose, and the time which had elapsed since the previous injection, showed that this was improbable. The only possible conclusion from this and other experiments was, that the first injection brings about a particular physiological state which makes the individual more sensitive to subsequent injections.

A further step was taken in 1903, when M. Arthus showed that the same physiological state could be induced by a substance, such as blood-serum, which is not in itself toxic. A rabbit, which had been injected with a dose of horse-serum without showing any signs of disturbance, a month later succumbed at once on receiving an injection of one-twentieth the quantity of the same material.

Anaphylaxis is invariably specific—that is, an animal rendered sensitive by previous injection to one substance, is not affected as regards any other substance, not even a different kind of blood-serum. This has an interesting legal bearing. It supplies a new and conclusive method of determining the source of any given blood, e.g., whether it is human or not. Thus if a set of guinea-pigs be treated with the serum of different forms, man, dog, horse, and so on—and after a month's interval be injected with a solution of the blood to be identified, the relevant guinea-pig will re-act at once, while the others will remain unaffected. Quaint, too, is the experiment of injecting an extract of the muscle of a human mummy into a set of guinea-pigs—for here, as elsewhere, the unfortunate guinea-pig has proved itself the best subject for experiment, its sensitiveness to a special substance being capable of being increased five-thousand times—and after an interval injecting other muscle-extracts. The animals re-acted to that of human muscle, and to that alone, "thus proving, if proof were needed, that the chemical constitution of the human body has not notably varied in the last three or four thousand years."

The medical aspects of anaphylaxis are discussed by Professor Richet in connection with the use of tuberculin; he regards the phenomenon as throwing light on its diagnostic value, and probably also on the occasional terrible accidents which for a time almost discredited it as a therapeutic agent. This latter point is still under investigation. The "serum disease," too, which sometimes follows the use of anti-toxin and inoculation for plague is

* "L'Anaphylaxie." Paris, 1912.

probably r[illegible] explained in popular way, and cases are described which show that a substance may be prophylactic against a particular disease, and yet anaphylactic against itself, so that anaphylaxis and immunity may be developed simultaneously. It is comforting to learn that physiologists have already devised an "anti-anaphylactic" method of procedure.

It has been shown that, while no crystallisable substance can produce anaphylaxis, almost any "colloid" or albuminoid substance (which is unable or hardly able to diffuse through organic membranes) may do so under certain conditions. Among these conditions are, that a certain time—an incubation period—must elapse between the doses, and that the substance, serum, egg, milk, muscle-extract, vegetable extract or whatever it be, must be introduced into the circulation. Alimentary anaphylaxis occurs very rarely, since it is the digested products of albuminoid substances, and not the substances themselves, that are absorbed into the blood. But the rare exceptional cases are of extraordinary interest, since they are the people, known to us all, to whom "eggs are poison," who cannot digest milk in any form, or who cannot eat a particular kind of shellfish without more or less severe symptoms, such as fever and nettlerash. Here, too, the phenomenon is absolutely specific, and Dr. Richet cites the case of a man who always showed violent symptoms after eating even a perfectly fresh shrimp, yet who could indulge freely in lobster without inconvenience!

There is also a "passive" anaphylaxis. If the blood of an animal anaphylactised in regard to a particular substance be injected into another animal, that also is rendered anaphylactic to the same substance. Interesting, too, is the fact that anaphylaxis in a mother, acquired either before or after conception, may be congenital in the offspring, but the condition is not usually of long duration. In guinea pigs it was noted on the forty-fourth day, but had disappeared by the seventieth day.

Professor Richet's discussion, based on his own experiments, of the precise way in which anaphylaxis is brought about, is too technical to be of general interest. Suffice it to say that he regards the first introduction of the albuminoid as modifying the blood by producing in it, during the incubation period, a chemical substance, which is not in itself toxic, but which is capable of becoming immediately and violently so in the presence of the original albuminoid. So numerous are the substances which may bring about modification, either in the direction of anaphylactisation or immunisation, that each individual of a species must differ from every other in chemical constitution; and the vague "idiosyncrasy" of the past must give place to a more definite conception of a chemical personality which embodies the results of the individual's physiological history, just as his psychological personality registers his mental experience.

But notwithstanding the differences between the individual members of a species, there is a typical specific chemical constitution which cannot be widely departed from if the species is to persist. And it is in this fact that Professor Richet finds the key to the apparent contradiction between anaphylaxis and the general biological law, that every living organism is in an optimum state of protection. "I am more and more convinced," he writes, "that every detail of the organism has a protective rôle, and is useful and even necessary to life, and that, therefore, a great general biological function like anaphylaxis must play an essential part in the defence of organisms. So that anaphylaxis appears to us an efficacious and energetic method of maintaining the chemical stability of our bodies by provoking an immediate and violent reactional response to the introduction of any substance which might change it. This is not the defence of the individual; it is the defence of the species at the cost of the individual."

ENGLISH LAKE DWELLINGS.

In 1880 I wrote a short note on the Swiss chalets as being the descendants of the old lake dwellings (*Nature*, October 7th). A subsequent writer drew attention to the fact that someone else had previously suggested the same thing. I now wish to draw attention to the fact that we seem to have had something of the same kind in England. In the "Life and Letters of Professor A. Sedgwick (Vol. I, p. 13–15) there will be found illustrations of houses in his native village of Dent which stands in a valley, presumably once a lake. The dale of Dent is situated in the westernmost extremity of Yorkshire, in which the River Dee now flows westerly into the Lune. The entrance to the long valley at the west end is represented on the map as five-eighths of a mile, or about eleven hundred yards.

The chief feature, both of the Swiss chalets and the houses in Dent, is to have an outside staircase or steps to the rooms above, which were surrounded by a "gallery," as Sedgwick calls it; but when he wrote they were fast disappearing. The lower, or "ground floor," is mostly used now for fodder, for the cow, in Switzerland; but is built in, in the houses in Dent. The left hand figure, however, on page 13, shows one still open. The gallery is seen on the left hand side of page 15. These two illustrations were made in 1820.

It would thus seem that the old Dent houses really carried on the tradition of a flat above the water, with the entrance by means of a staircase outside, down to the water.

A curious hint (as it may perhaps be called) is seen in the Babylonian cosmogony discovered by Mr. G. Smith in 1872, which seems to have been—or some other more or less like it—the source of Genesis i. One of the tablets says:—

"(Anu) made suitable the mansions of the (seven) Great Gods.

The stars he placed in them.

. . . .

The mansion of Bel and Hea he established along with himself.

The bolts he strengthened on the left hand and on the right.

In its centre also he made a staircase."

The house is thus built *over* the "Water *above* the firmament." Since the air or "firmament divided the waters (clouds) from the waters (ocean)." (Genesis i, 6).

The house, therefore, with its staircase, would seem to have been built after the same fashion of an early lake dwelling somewhere near the Persian Gulf.

George Henslow.

THE DISCAL FLORETS OF *SENECIO JACOBOEA*.

BY SIR W. W. STRICKLAND, B.A.

A GOOD many years ago, I began a series of observations on the phyllotaxis of composite flowers, in the North of Italy. By a curious coincidence, Professor Ludwig of Gratz was making very similar observations, which he published about the year 1894. But while he confined himself to the ray florets I have more or less completely solved the problem of the discal florets, and the solution, if my observations are ever published, will completely transform our ideas of the evolution of organic form.

What has been established with absolute certainty about the rayed florets of the Compositae is that, in the vast majority of cases, where they do not exceed fifty-five in number—beyond which statistics have not yet probed, they follow the law of phyllotaxis. In other words, in the vast majority of cases the rayed florets are three, five, eight, thirteen, twenty-one, thirty-four, and perhaps fifty-five in number. Eight and thirteen are also doubled and in the small wild calendula we have a maximum at twenty-six, with the principal maximum at sixteen, and in the common wild blue chicory (*Intyba chicorea*) at sixteen with a large sub-maximum at fifteen. A scarce large flowering Achillea found near Sonnico below Edolo—the specific name of which I forget, and, not having my notes with me, consequently cannot give—has also sixteen rays, and doubtless there are many other instances. With respect to the number twenty-six, I cannot as yet give an explanation, but as regards sixteen there is a good deal to be said.

Intyba chicorea, as observed, gives a small maximum at sixteen, very nearly reached by the sub-maximum at fifteen, after which there is a large drop, and the reason of it is apparent to the naked eye. Naturally when the seeds set, the fruits retain the position of the florets. In these flowers of *Intyba chicorea*, the seeds set in the form of a more or less pentagonal tessellated pavement, and in the case of the seed-head with the sixteen constituent parts, the arrangement was also obvious to the naked eye. A ring of five fruits was surrounded by a ring of eleven. I then analysed geometrically the seed-heads of *Intyba chicorea* for all numbers from thirteen to twenty-one, and it was demonstrated, with mathematical certainty, that *in all cases* they represented *whole or partial* concentric rings of circles beginning with a ring of five. Thirteen represents a ring of five surrounded by eight out of the eleven of the second ring, sixteen represents five surrounded by the complete second ring of eleven, twenty-one represents sixteen with five out of the seventeen of the third or next outer ring, and so of all the rest. I need not, perhaps, remark that each concentric ring increases by six circles composing it so that three complete rings of circles sum $5+11+17=33$.

As I have said, the reason why in *Intyba chicorea* we have a maximum of sixteen florets and a sub-maximum of fifteen is obvious at once, because sixteen is the sum of the first and second rings of two concentric rings of circles beginning with a ring of five. Another botanical fact in connection with these discoveries clenches the argument and throws a flood of light upon the evolution of form. An allied species to *Intyba chicorea*, but rarer and growing in drier and stonier habitats, is *Scariola*. It is yellow flowering, often found by rocky beds of torrents dry in summer. Its chief habitat is the lower part of the Val de Sole, a stony valley with vast moraines from the glacial epoch, in that part of the Austrian Tyrol which ought to belong to Italy. Here the flower heads of *Scariola* are, I may say, invariably composed of eleven florets. Although eleven is practically the invariable number, last autumn I found a few plants of a dwarfed *Scariola*, growing at the foot of a high stone wall, flanking the exposed and dusty road from Salò to Maderno on the Lago di Garda. The spot was dry and stony, without grass and with hardly anything else but the *Scariola* growing upon it. A great many of the flower-heads of these plants were composed of only ten florets. Why has *Scariola* eleven florets? The reason seems to me clear, viz., that when *Intyba chicorea*, which is found on grassy roadsides, straggled on to stony ground, all its parts shrunk, the florets turned yellow, the stalks grew thinner and lankier and the inner five florets were squeezed out of existence, and only the eleven outer circlet of florets remained. Further contraction caused a re-arrangement visible to the naked eye: three of the eleven forming an inner circle of three, surrounded by a ring of eight: which corresponds to two concentric rings of circles, beginning with a ring of three with one of the outer nine missing. That this is the true explanation can be inferred from other similar facts. *Prenanthe muralis* is a form of hawkweed though put in another genus, which, as the name implies, is attached to a stony habitat, and has its florets reduced invariably to five in number. A similar *Prenanthe*, but rarer and with purple flower heads, haunts similar localities, and its flower-heads also consist invariably of only five florets. It is abundant about Torno on the Lake of Como, and is remarkable for the fact that it is practically impossible to dry it and prevent its florets from turning to fruits in the process. Something of the same kind occurs in the subject of the present essay. When flowers belonging to plants growing on stony ground are analysed, it is found that the ligules of the rayed florets are longer than those of plants growing on relatively rich soil, also the discal florets are much less numerous. Thus in the former case the number of discal florets ranges from fifty to [illegible] hundred and rarely exceeds the latter number, whereas in the latter, the number of discal florets ranges from one hundred to one hundred and fifty-five and rarely sinks below one hundred. Moreover, the rayed florets are broader and shorter. For some reason not explained many composite flowers at a high level tend to develop their rayed florets.

All over the North of Italy the common ox-eye daisy has an enormous majority of flowers with twenty-one rays. In the same localities in the autumn, towards the termination of the flowering season, two sub-maxima occur, consisting of comparatively dwarfed flower-heads on *non-branching* plants, in which the great majority of rayed florets are respectively eight and thirteen in number.

On the other hand a little after the beginning of the flowering season, at high levels, on garden soil, facing south, plants can be found with a large majority of flower heads, with rayed florets thirty-four in number, which is the next phyllotaxis number above twenty-one. I demonstrated this with the utmost certainty, in the case of ox-eye daisy growing in high level localities, near Rovena above Cernobbio, Lago di Como. On Monte Grigna, the Eastern or Lecco branch of the lake, occurs at still high levels a rare and gigantic species called, if I mistake not, *Chrysanthemum imbricatum*, which doubtless has thirty-four and perhaps fifty-five elongated rayed flowers, but I have not as yet obtained specimens. Another instance, however, of the development of the ray florets is the wild Arnica, which occurs at comparatively high levels, not as a rule below four thousand feet, on pastures (above Brunate, Lago di Como) or on marshy meadows (Tonale Pass, Val Camonica). In valleys by slow-running rivers and in other similar localities just the opposite occurs. The rayed florets become broad, short and few in number or disappear altogether, while the number of the discal florets increases. A common instance of this is *Gallinsoga canadensis*, found all over the North of Italy, and also in the South of England, where it was introduced about thirty years ago, and rapidly spread down the Thames Valley from Kew to Oxford. In this plant the rayed florets are reduced to invariably five in number (broad and scale-like) having been crowded out by the discal florets which form a thick convex topknot. In the common tansy (*Tanacetum vulgare*) which haunts the banks of low-level or comparatively low-level rivers, the rayed florets have disappeared altogether, and the discal ones become numerous and close packed. *Tanacetum vulgare* is never found with its distant relation the romantic edelweiss in its ideal sites of snow and ice. A perhaps still more remarkable instance occurs in Australia and New Zealand. In tropical and hot sub-tropical countries composites are not as a rule plentiful: thus in New Zealand, *i.e.*, in the North Island and in Eastern Australia (for strange to say in hot Western Australia there is a wonderful development of novel forms of composites) there is only one that strikes the eye, a small creeping plant, growing in moist spots, and lush water-meadows, with flower buttons similar to those of the tansy, but smaller and more hygrophanous. On the other hand in the almost sub-Arctic and rugged Stewart Island, there are several composite shrubs and small trees, the flowers of which abound in rayed florets.

To sum up the results so far as indicated by the above remarks. In all composite flowers with rays, the number of which does not greatly exceed thirty-four, the vast majority of flowers have two (rare), three, five, eight, thirteen, twenty-one and thirty-four rays, or, in some few cases, double eight and double thirteen *i.e.*, sixteen or twenty-six. Again, in a few plants of which the florets are all liguled, and not differentiated into rayed and discal ones, *e.g.*, in chicories and prenanthes, the flowers represent two rings of the concentric ring system, beginning with a ring of five, or more rarely one of the rings (five or eleven) or again one ring (five) and part of the second or two rings (five and eleven) and part of the third. As regards the discal florets of composite flowers differentiated into disc and corona, nothing has so far been said.

Some years ago I attempted to estimate, at Cernobbio, the number of discal florets of the small, late autumn form of the ox-eye daisy with thirteen rays, by counting the number of discal florets in a cross section of the disc or eye, but soon found that to estimate the number of discal florets in a closely-packed disc like that of the ox-eye daisy was an impossibility, or, at any rate, a perfectly futile waste of time; because, owing to crowding, numbers of florets were reduced to pin points, or crowded out of existence altogether, so that an estimate of what remained could only yield statistics on which no sound reasoning could be based. I therefore turned my attention to the small wild calendula, abundant in most coast regions all down the Italian Peninsula. The observations were made at Taormina, on what may almost be called a gigantic scale, and resulted in the demonstration of a law so simple and yet so wonderful, that even now, although the evidence is overwhelming, I still regard it with a modicum of scepticism. I shall reserve the enunciation of it until the whole voluminous series of observations are published, when, if they ever are published, the law in question will excite wonder, astonishment and delight in everyone not dead to these sentiments and emotions. For the present I confine myself to a general statement that in the calendulas, as in the chicories and prenanthes, the discal florets are arranged in concentric rings of florets in a majority of the flower heads.

The other day, some plants of *Senecio jacoboea* (common ragwort) reminded me that this is one of the very few composites the flower-heads of which have almost invariably thirteen rays, more exactly ninety-eight per cent. and a fraction, so that this plant may claim a certain community of ideas with one of the pseudo-cycads, the flower of which, a thirteen-rayed star, was figured in "KNOWLEDGE" (May, 1910, page 174), and of interest as supposed to be

one of the ancestors of our buttercups and daisies and other phanerogams, and it occurred to me that it might be worth while to see if any conclusions could be drawn from counting the discal florets. In picking the flowers to pieces it was observed that there were some dwarfed and aborted discal florets, but not nearly so many as in the case of the thirteen-rayed ox-eye daisy, no doubt because the number of discal florets (range about fifty to one hundred and fifty-five) was much smaller and consequently they were less crowded. This would, however, mean a certain negative error; again, owing to the greater number of the florets, the errors in counting would also be greater than in the case of the calendulas, and such errors are generally negative ones. A floret is passed over uncounted. It is to be observed, however, that these errors do not tend to false conclusions, but only to diminish the evidence for a maximum, if one exist; for example, suppose a plant like *Senecio jacoboea* has generally thirteen rays: in counting the rays we are much more likely to make a mistake in the case of a thirteen-rayed flower, than in a twelve or fourteen-rayed one, because there are hardly any of the latter, and the same is true to a less extent in the case of flower-heads with a smaller maximum or maxima. On the other hand, if there be no sensible maxima, and there is pretty nearly the same number of flower-heads with one number of discal florets as with another within the whole range, we are as likely to count one number wrong as another, so that the errors will not build up a fictitious maximum, but, if we go on long enough, more or less completely cancel one another out.

The discal florets of three hundred flower heads were counted. The subjoined diagram summarizes the result, which, considering the small number of flower-heads counted and the sources of error above alluded to, is sufficiently striking and complete. Three possibilities occur to one.

1.—The discal florets may represent phyllotaxis numbers or their doubles.

2.—Concentric rings and their doubles.

3.—Or they may be multiples of five.

In one hundred and five consecutive numbers, the number of multiples of five to the whole number is roughly six to twenty-one, or about eighty-eight to three hundred; and it was found that in the countings the number of multiples of five was considerably below this average that chance would have given, so that the discal florets tend not to be produced in groups or multiples of five.

We have, therefore, only to consider phyllotaxis numbers, concentric ring numbers and their doubles.

Referring to the diagram we see that there is a shadowy, very shadowy, tendency for maxima to coincide with numbers representing concentric rings of circles. It is possible that the maxima at one less than these numbers, of which there are four, may really belong to these numbers, errors of counting or the abortion of discal florets having reduced them by one. The most important of such maxima is at one hundred and twenty representing six concentric rings of florets beginning with a ring of five.

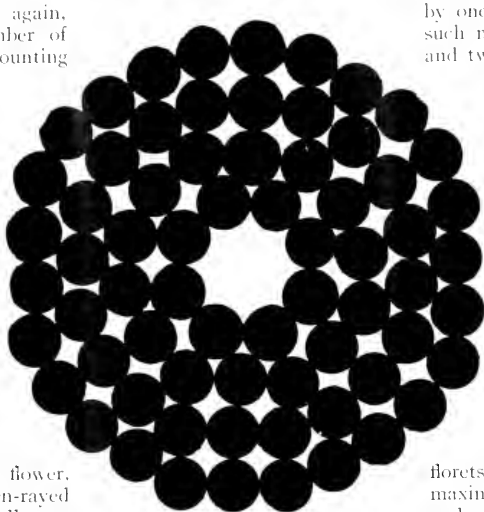


FIGURE 330.
The primitive form of *Senecio* as deduced from *Senecio jacoboea*.

The three really important maxima are, however, at eighty-nine, one hundred and ten, and one hundred and twelve. The eighty-nine maximum is explained at once, eighty-nine being the next phyllotaxis number above fifty-five. The absence of a maximum at fifty-five is due to the fact that there are hardly any flower-heads of *Senecio jacoboea* with less than sixty discal florets. How are the two principal maxima at one hundred and ten and one hundred and twelve to be explained? Evidently they are due to the doubling of the two numbers, fifty-five the phyllotaxis number, and fifty-six which represents four concentric rings of the ring system beginning with a ring of five (5, 11, 17, 23=56). I am afraid those who have no practical knowledge of the working of the phyllotaxis and concentric circle law in the evolution of composite flowers will hesitate to accept the inference, which, however, I believe to be valid, viz., that *Senecio jacoboea* has been developed from a more primitive form, which flourished on poor or rocky soil, by straggling on to a more fertile habitat. All organic life develops by dichotomy (cell division) giving numbers 2^1, 2^2, 2^3—2^n. At the beginning of this series eight and sixteen gave a ring of three surrounded by a ring of five (imperfect five instead of nine, but corresponding to vast numbers of phanerogam flowers) and the perfect system of five surrounded by a ring of eleven, giving 2^4 or 16, and considering the maximum at one hundred and twenty, six concentric rings beginning with one of five, it is not wonderful if the primitive form had a closely similar arrangement, viz., four concentric rings beginning with a ring of five. If to the phyllotaxis number, fifty-five, we add the other, thirteen, the number of the rayed florets, we get the number sixty-eight, which corresponds to four concentric rings of circles of the ring system beginning with a ring of eight (8, 14, 20, 26 = 68) (see Figure 329). The outermost ring contains just twenty-six florets so that every other floret would be a rayed one. In the analysis of the calendula there were reasons for believing that sometimes a certain number of the discal florets was disposed symmetrically in the outermost, that is, the ring of rayed florets. Let us suppose the cell from which the composite flower-head sprung submitted to three cell divisions and we get eight (2^3) cells and if these arranged themselves in a ring of eight they would form the basis of the above-mentioned system in the ancestral *Senecio*. This may partly explain the evolution of the phyllotaxis number thirteen, or in certain cases but only partially. The system gives an *approximately* regular thirteen-rayed star.

A word of warning is necessary regarding the diagrammatic mode of representing statistics now so much in vogue, at least as regards the present diagram. The two chief maxima appear sufficiently striking, but making all due allowance for negative errors and aborted florets, they only represent maxima of about five per cent. We need not suppose, therefore, that the more primitive type had all its flower heads with fifty-five or fifty-six discal florets; twenty-five per cent. of each would be quite enough to account for the maxima in the present instance. It so happens that the next lower phyllotaxis number for three concentric rings of circles beginning with a ring of five (thirty-three), and the next lower phyllotaxis number thirty-four, also only differ by unity, in this case the phyllotaxis number being the greater.

The next phyllotaxis number twenty-one has no number of the five ring systems at all near it, but the thirteen has sixteen or two concentric rings of circles, beginning with a ring of five corresponding to two maxima in *Intyba chicorea*. There is another very remarkable case where the phyllotaxis number thirteen occurs invariably in certain of the animal and not vegetable kingdom.

Leaving this more or less speculative field, the fact remains demonstrated that the four principal maxima of the discal curve of *Senecio jacoboea* represent:

(1) The phyllotaxis number 89.
(2) The phyllotaxis number 55 doubled = 110.
(3) The sum of four concentric rings beginning with a ring of 5 doubled = 112, and
(4) The sum of five concentric rings beginning with a ring of 5 = 120.

Those who have hitherto believed that the evolution of symmetrical form can be explained by "protection" and "survival of the fittest" in its ordinary sense, at the conclusion of this essay may perhaps be less confident in their assertions. The fact is that the fatal gift of symmetry exposes the possessor of it to a host of enemies. The naked eye can detect almost microscopically small snail shells on account of their symmetry, and to protect them "protection" and "natural selection" so far from evolving symmetry, have to evolve all sorts of devices to mask it, carried to extreme lengths in certain sea horses and stick-insects. "Protection" and "natural selection" are not invoked to explain the symmetry of crystals, and there is not a shred of evidence to prove that they have any more to do with the evolution of organic than with the evolution of crystalline symmetry. I may conclude by saying that the law of the exposure to risk from symmetry is universal, and is found in the moral as well as the organic world.

Note. Since writing the above, I took a walk to a spot (above Cimburg) about one thousand metres above sea level. Here, on rocky ground, was growing a somewhat viscid plant something between a groundsel and a ragwort. I believe it is classed as a ragwort. I brought home a few heads which gave the following result:

Rays.	Discal Florets.	
13	41	= 55 or 4 rings of 5-ring system — 1 the phyllotaxis number.
13	42	
13	42	
13	43	
13	33	*i.e.*, 13 and 3 rings of the 5-ring system.
13	39	*i.e.*, 13 and 3 rings of the 7-ring system.
13	36	
10	31	

VENUS: THE PLANET OF MYSTERY

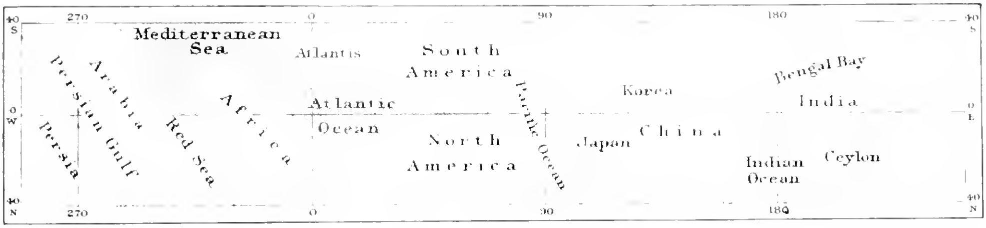
By FRANK C. DENNETT.

No other planet shines with such a brilliant light as Venus, either as an evening, or as a morning star; so brilliant even that it will throw a very evident shadow. Although a little less in size than the Earth, when nearest to us, it attains an apparent diameter greater than that of any other planet. Notwithstanding its closeness, an air of mystery has seemed to hang over its study, making the work of different observers yield most contradictory results.

Its supposed satellite was observed first by the elder Cassini, who wrote thus: "A.D. 1686, August 28th, at fifteen minutes after four in the morning, looking at Venus with a telescope of thirty-four feet, I saw at the distance of one-third of her diameter eastward a luminous appearance of a shape not well defined, that seemed to have the same phase with Venus, which was then gibbous on the western side. The diameter of this phenomenon was nearly equal to a fourth part of the diameter of Venus. I observed it attentively for a quarter of an hour, and having left off looking at it for four or five minutes I saw it no more; but daylight was then advanced. I had seen a like phenomenon which resembled the phase of Venus, January 25th, A.D., 1672, from fifty-two minutes after six in the morning to two minutes after seven, when the brightness of the twilight made it disappear. Venus was then horned; and this phenomenon, the diameter whereof was nearly a fourth part of the diameter of Venus, was of the same shape. It was distant from the southern horn of Venus a diameter of the planet on the western side." The next observations were made by the celebrated reflector-maker, James Short, on the morning of October 23rd, 1740, using a 16·5 inch reflector, magnifying between fifty and sixty, when he measured a star 10′ distant from the planet. Using powers of two hundred and forty and one hundred and forty, the little object was found to be rather less than one-third of the planet's diameter in size, and presenting a circular phase. He saw it several times during about an hour, but never afterwards found it. On four evenings during May, 1761, M. Montaigne, of Limoges, saw what seemed to be the satellite, always presenting the same phase as the planet, and one quarter of its diameter, but in altered positions. During March, 1764, Rodkier, Horrebow and others with a refractor at Copenhagen, and Montbarron at Auxerre with a reflector repeatedly observed this object. Subsequently, Lambert collected the whole of the observations and calculated its orbit, publishing the calculations in Bode's *Jharbuch* for 1777. To allow the supposed moon, however, to complete its circuit in $11^d\ 5^h\ 13^m$ at a distance of two hundred and fifty five thousand miles, as calculated, the mass or weight of Venus would have need to be increased tenfold. Doubtless the supposed satellite was a "ghost" in the eyepiece, yet it must be admitted that Short's use of at least three eyepieces is very puzzling. Since 1764, however, the "ghost" seems to have made no further apparitions.

Perhaps the greatest paradox has been the rotation period, some observers finding it to be less than a day, whilst others have thought it was nearly or quite equal to Venus' orbital period of two hundred and twenty-five days. The real trouble seems to be due to the different sensitiveness of different eyes to certain light rays. Cassini, who appears to have paid special attention to bright spots, wrote: "The space on these" (Mars and Jupiter) "I could attentively observe for a whole night, when the planets were in opposition to the Sun; I could see them return to the same situation, and consider their motion during some hours, and judge whether they were the same spots or not, and what time they took in turning round: but it was not the same with the spots of Venus, for they can be observed only for so short a time, that it is much more difficult to know with certainty when they return into the same situation. I can, however, supposing that the bright spot which I observed on Venus and particularly this year was the same, say that she finishes her motion, whether of rotation or libration, in less than a day: so that, in twenty-three days nearly, the spot comes into the same situation on nearly the same hour of the day, though not without some irregularity." In 1667, on April 20th, he observed the motion of the bright spot during the period of his observation. The period according to Cassini, the younger, was $23^h\ 21^m$. In 1726-27 Bianchini with a two and a half inch refractor, no less than sixty-six feet in length, came to the conclusion that the rotation occupied $24^d\ 8^h$, the error doubtless arising from his small means and the short time he could follow the object of his study. Schroeter, from eight observations of a fixed point on the surface, obtained a rotation period of $23^h\ 21^m\ 7 \cdot 98^s$. At the Vatican Observatory, Rome, De Vico and his helpers, 1839–41, found a period of $23^h\ 21^m\ 22^s$, a result obtained after an enormous amount of work. In 1890, Schiaparelli, after discussing all available material, came to the conclusion that rotation was slow, not less than six or more than nine months. He seems to have in some way misread Cassini, and supposed that his period was twenty-three days. Other observers, such as Terby, Perrotin, and Lowell confirmed Schiaparelli, and the general conclusion of such has been that the rotation period is probably identical with the period, in other words is two hundred and twenty five days. Niesten and Stuyvaert, at Brussels, observing in 1881 and 1890, supported the short rotation period, as also did Trouvelot. Brenner gave the period as $23^h\ 57^m\ 36^s$, and latterly McHarg, from his own observations and all available material, finds the period to be $23^h\ 28^m\ 13^s \cdot 595$, and constructs a map of its surface, which we reproduce. On the other hand, Mascari came to the conclusion that the period was slow.

Long ago De Vico noticed that the observers who were best able to see the markings on Venus were those who had the greatest difficulty in seeing minute companions to bright stars. The writer sees the markings with ease in a good air, yet at the same time the details lack the sharpness of many of the Martian markings. At the same time the motion from rotation could be watched in half an-hour as readily as could that of Mars. The only conclusion that can be arrived at is that some observers do see the surface of the planet modified by an atmospheric envelope, whilst others fail altogether. Can this be due to a form of colour blindness? the markings being of a tint to which some eyes are susceptible and others not. This fact, if accepted, would explain a good many of the mysteries of observational astronomy. Mascari's observations can possibly be explained in another way. If the little map be examined it will be noted that large dark markings are situated one hundred and eighty degrees apart, whilst midway between them on either side only very delicate details occur. Mascari seems to have thought the dark markings were both the same, and when the intermediate portions were presented he was unable to see anything.



From a drawing *J. J. McHarg, M.A.*

Figure 331. Map of Venus.

Perhaps the greatest mystery is yielded by the spectroscope. In 1900, Belopolsky, at Moscow, found the lines were curved at the limb to an extent only to be explained by a quick rotation. This seemed to give a definite answer. However, in 1903 the spectroscope at Flagstaff Observatory, in the hands of Slipher, gave absolutely contradictory results. The news was given in the number of *The Observatory* for August, 1911, that the Russian observer has continued his researches, and that the results of 1903, 1908, and 1911 confirm those previously obtained. Moreover, the instrument has been verified on Mars, the rate of whose rotation is known. "He found for its equatorial velocity 0·354 kilometres per second, instead of 0·254 kilometres. The value found for Venus, 0·38 kilometres, corresponds to a period of rotation of 1·44 days."

There is another mystery respecting Venus, to which only allusion must be made—the visibility of its unilluminated surface near inferior conjunction. Some observers have recorded that the disc appears dark on a brighter background. Others, however, maintain that it appears brighter than the background upon which it is seen. The former can easily be explained, but it is strange how a dark body can appear brighter than a somewhat illuminated background. Even an explanation of auroral lighting is very inadequate when we consider the brightness of the background upon which it is seen.

THE KNOWLEDGE OF THE MAKERS OF SCIENTIFIC INSTRUMENTS IN THE SEVENTEENTH AND EIGHTEENTH CENTURIES: THEIR TRADE-CARDS AND OTHER RARIORA.

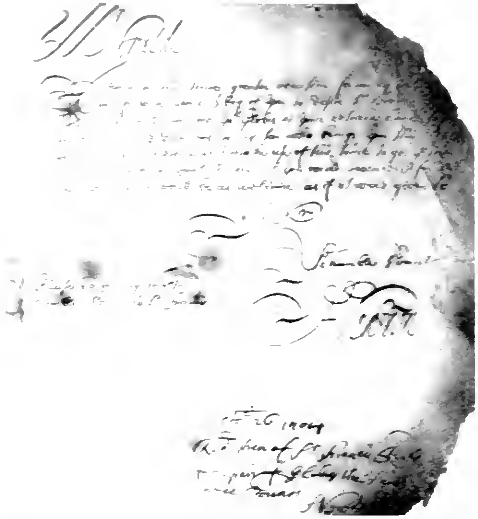
By A. M. BROADLEY.

Author of "The Royal Miracle."

ALTHOUGH the Guilds of the Clockmakers and the Spectaclemakers occupy a prominent position amongst the ancient Livery Companies of the City of London, the manufacturers of scientific instruments of various descriptions not coming within these two categories do not appear to have ever obtained a charter or sought the benefits and privileges of incorporation. This is the more curious and inexplicable as the "art and misterie" they follow has flourished for considerably more than three centuries, and in many cases they can boast of a continuity of business association rarely to be met with in other callings. In his "History of the Livery Companies of the City of London" Mr. W. Carew Hazlitt mentions the fact that in 1672 the incorporated or voluntary associations of the Cartwrights, Boxmakers, *and Instrument-makers* were mentioned as branches of the Carpenters; but one would imagine that the artificers thus referred to were engaged in the production of saws and chisels rather than in that of the necessary aids to mathematics or navigation. It is curious, however, to note that the germ of the Clockmakers' Guild is to be found in the muniments of the Blacksmiths, who, both here and on the Continent, as Mr. Hazlitt points out, "once and long occupied a station importantly differing from the workmen of the same denomination familiar to ourselves and our immediate predecessors." It may also have been thus with the Carpenters. When the existing Clockmakers' Company was constituted in 1631, scientific clockmaking had already made very considerable progress, and the Coffin-Clock was an established fact of some standing. The makers of primitive timepieces were at first intimately connected with both the Blacksmiths and the Woodmongers, and it was a difference with the former which led to the petition for separate incorporation in 1629-30. The charter of the Clockmakers bears the date of August 22nd, 1631, and its initial letters contain a well-executed miniature of King Charles I enthroned. The Company can count on its roll of members nearly all the most distinguished masters of the art: from David Ramsey, the first Master, down to William James Frodsham and other well-known clockmakers. One of the most eminent makers of clocks of the early seventeenth century was Edward East, and it is said that the granter of the charter, when Prince, used to play tennis for an *Edwardus East*, or, in other words, a watch of East's manufacture. Thomas Tompion and George Graham were equally famous in their day, the latter being a member of the Royal Society. They were both buried in Westminster Abbey, and Dean Stanley was instrumental in recovering and replacing the slab recording the fact, which had been removed. The

FIGURE 332. John Dollond.
Engraved by A. Posselwhite, from an original picture in the Royal Observatory, Greenwich.

FIGURE 333.
The Copley Gold Medal of the Royal Society, awarded to John Dollond in the year 1758.



Nathaniel Hill [illegible] 128, Chancery Lane [illegible] of the Fleet [illegible] ner. Nathaniel Hill was [illegible] ded [illegible] shew [illegible] on by law to the New[illegible] from he succeeded in the firm.

The Newt[illegible] of Newton and Company, [illegible] descent from one Isaac Newton, who flourished in Lincolnshire in the reign of Henry VII. It was one of his descendants, John Newton, born in 1649, and a cousin of Sir Isaac Newton (1642—1727), who founded the business which in the middle of the eighteenth century and later was carried on by Nathaniel Hill, at 128, Chancery Lane, close to the Fleet Street corner. The John Newton born in 1649 had a son, born in 1678. Nathaniel Hill took into partnership one of the Newton descendants, who also bore the same name. The John Newton born in 1759, and who lived till 1844, gave the copy of the trade card possessed by the firm to his son William, who was born in 1786. The copy of the card already mentioned as belonging to the present writer is endorsed 1756, so the Newton partnership probably took place about the time of William Newton's birth. It was William Newton who moved the place of business of Newton & Company, the successors of Nathaniel Hill, the successor of John Newton, from 128, Chancery Lane, to 66, Chancery Lane. William Newton was succeeded by his nephew Frederick Newton (1824-1909) who migrated to 3, Fleet Street. Mr. Herbert Charles Newton, now a member of the firm, was born in 1853.

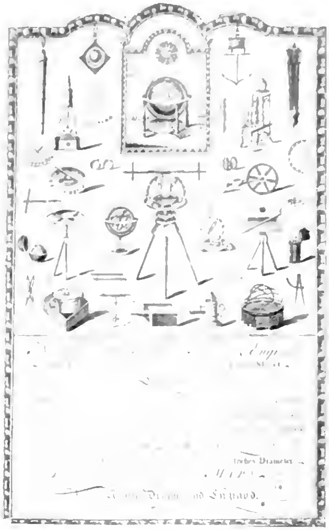


FIGURE 336.

Trade Card of Nathaniel Hill, Globe Maker and Engraver, at the Globe and Sun, Chancery Lane, Fleet Street, about 1750.

Several interesting documents relating to the first phase in the history of the premier firm of scientific instrument-makers were discovered in the chamber above Temple Bar, when it was pulled down in January, 1878, and given by Messrs. Child to Mr. Frederic Newton. The letter reproduced in Figure 335 runs as follows:—

Mr. Child

> I have at this time greater occasion for money than I have had for some years. I beg of you to desire Sr Francis . . . . . told me he would pay for ye Globes at your return home to pay the same, viz 3 Guineas to my son who brings you this; I assure you it is not a pretence y^t I make use of this time to get ye money paid, but I really want it now; if you would procure it for me this morning, it would be as welcome as if it was given to
>
> Sir
>
> Yr humble s'vant
>
> J. NEWTON

Please to give my most humble s'vice to S^r Francis

FIGURE 338.

Trade Card of Richard Gearing, Mathematical Instrument Maker at the Quadrant without Newgate, facing the Old Bailey, [illegible] 1750.

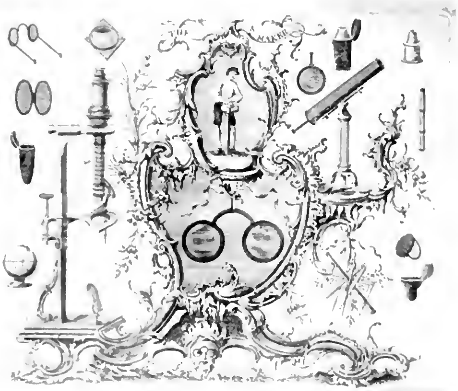


FIGURE 337.

Very [illegible] card of about 17[illegible] showing the whole process [illegible] making. Certain emblems disclose the fact that [illegible] maker in question was a Freemason.

Octo 26 1704

Rec^d then of S^r Francis Child for a pair of Globes the sum of three pounds.

J. NEWTON

M^r Tho. Child
at y^e R^t $Worp^{ll}$ S^r Fr Child
near Temple Barr
Lond

Other memoranda and accounts run thus:—

$Worp^{ll}$ S^r Francis Child —
— Teaching his Son M^r Thomas Child —
viz. — of Geometry —
Trigonometry Rectangular & Oblique angular & Plane Sayling
for oblique sayling currents turning to Windward
Mercators sayling the Construction & use of the Plane.
& of Mercators Charts, the sum of six pounds — me

J. NEWTON.

FIGURE 339.
Trade Card of Benjamin Cole, a famous optician, carrying on business in Fleet Street, cir 1760

Ditto Rec of y^e R^t Worp^ll S^r Francis Child y^e sum of five pounds, 13 shillings & 6 pence in full of all Acc^t disbursed by me for Books & Instrum^ts

	£	s.	d.
viz. A Sector	4	6	0
A slyding Rule best (?) ...	0	5	0
Two folio papyr books ...	0	14	0
A slate	0	01	0
A pen (?)	0	03	6
A pair of slate Compasses ...	0	02	6
The use of a Drawer ...	0	01	0
	£5	13	0

It was in 1750 that the still-existing firm of Dollond, with its branches east and west of Temple Bar, was founded by John Dollond (see Figure 332), an active and prominent member of the Royal Society, which last month celebrated the two hundred and fiftieth anniversary of its incorporation. Dollond, born in June, 1706, was the son of a Huguenot refugee, a Norman weaver, who settled in Spitalfields, then the recognized centre of English silk-making. In spite of an imprudent early marriage and other difficulties, which to most men would have been insurmountable, Dollond made himself a master of many languages and many sciences.

The eventual trend of John Dollond's researches, however, was towards the kindred departments of astronomy and optics, and in 1750 he abandoned the weaver's craft and entered into an alliance with his son Peter Dollond—already an ardent scientific inquirer, one day to achieve distinction. They together became practising opticians, meanwhile engaging themselves enthusiastically in the work of investigation and improvement in connection with the instruments they fabricated. It is more than likely that Figure 337 of an interesting optician's card of this period emanated from the Dollonds, as it demonstrated very artistically and effectively the whole process of spectacle-making. If this surmise is correct one or other of the Dollonds must have belonged to the Order of Freemasons, which, in its present form originated in 1717, and between that date and 1750 was closely associated with the Royal Society. The discoveries of John Dollond overthrew a cherished theory of Sir Isaac Newton, and ended not only in the actual discovery of the achromatic telescope, but its practical application. In 1758 the Copley Gold Medal of the Royal Society (see Figure 333) was awarded to John Dollond, who, in 1761, was appointed Optician to George III. An invoice dated 1763 is shown in Figure 334. The house has continued from the hour of the foundation upon one unbroken course of development and expansion down to the present day. The traditions framed by John Dollond, the Huguenot weaver, and the principles he outlined upon which to conduct his business, remain unchanged, except where change has meant improvement.

FIGURE 340.
Trade Card of John Bennett, Maker of Mathematical, Philosophical and Optical Instruments to the Dukes of Gloucester and Cumberland, at the sign of the Globe, Crown Court, St. Ann's, Soho, 1760

FIGURE 341.
Trade Card of James Simons, Mathematical, Philosophical and Optical Instrument Maker, at the sign of Sir Isaac Newton's Head at the corner of Marylebone Street, opposite Glasshouse Street, 1785

The most delicate and intricate weighing operations carried out by Messrs. Garrard, the Court Jewellers, are still performed with a machine of

FIGURE 342.
Trade Card of R. Rust, Nautical Instrument Maker, at the corner of St. Catherine's Stairs, near the Tower of London, 1745

FIGURE 343.

Trade Card of Fisher Combes, Maker of Mathematical and Nautical Instruments, at the Sign of the Mariner and Globe, in Broad Street, opposite the Angel and Crown Tavern, behind the Royal Exchange, 17[illegible].

marvellous precision, made in 1777 by the firm of De Grave, Short & Co., whose business as scientific scale-makers was founded in 1670 at the corner of St. Anne's Lane, now Gresham Street. The house of De Grave, Short, had been in existence more than sixty years, when the originators of the house of Garrard set up the sign of the Golden Lion, in the Haymarket. The balance of 1777 was one of the heirlooms which were removed with scrupulous care to the new home of the great firm in Albemarle Street. It is greatly to be regretted that the archives of the [illegible] scale-makers who have existed during portions of four centuries, have been lost. It seems likely that the founder of these businesses was, like John Dollond, a Huguenot.

Richard Gearing, whose trade card of the period

FIGURE 344.

Trade Card of William Watson, a Maker of Compasses and other Nautical Instruments, in Church Lane Stairs, Hull, 1755.

GEORGE ADAMS,

MATHEMATICAL Instrument-Maker *to his Majesty's Office of* ORDNANCE,

At Tycho Brahe's *Head, the Corner of* Racquet-Court, *in* Fleet-Street, *LONDON*,

MAKES and SELLS all Sorts of the most Curious MATHEMATICAL, PHILOSOPHICAL, and OPTICAL INSTRUMENTS, in Silver, Brass, Ivory, or Wood, with the utmost Accuracy and Exactness, according to the latest and best Discoveries of the modern Mathematicians,

HIS New SEA QUADRANT, by Refraction, for taking the Sun's Altitude, either in a backward or forward Observation. Also the Sun's Magnetical Azimuth, and thereby the Variation of the Needle, may be obtained by the same Quadrant, by means of a particular Compass, which may be applied to it.

Mr Jack's New REFRACTING TELESCOPE for viewing distant Objects.

He likewise Makes and Sells *Hadley's* QUADRANTS in the most exact Method, with Glasses whose Planes are truly parallel; *Davis's* Quadrants, &c.

Large ASTRONOMICAL QUADRANTS, TRANSIT and EQUAL ALTITUDE INSTRUMENTS, for observing the Transits of the Sun and Stars over the Meridian, &c. Telescopes fitted with a Micrometer, &c.

Sun D[illegible] H[illegible] for [illegible] in any Latitude, with Variety of [illegible] either UNIVERSAL, or for several different La[illegible] with new Improvements.

Choice of [illegible] Cases of DRAWING INSTRUMENTS, in Silver, Brass, &c. containing a Sector, Scales, Proportionable and other Compasses, Drawing P[illegible], Protractors, Parallel Rules, &c.

A[illegible] New [illegible] Portable M[illegible] for viewing all Kinds of M[illegible] Objects, as well Opaque as Transparent, in so conspicuous and [illegible] a Manner, as to comprehend all the Uses of all the other [illegible] Microscopes in one Apparatus, and magnifies to so great a Degree, as to discover the Circulation of the Blood in A[illegible] M[illegible] in Insects, [illegible] of Vegetab[illegible] [illegible] Phænomena [illegible] not percep[illegible]

A[illegible] either Double or Single [illegible]

R[illegible] or [illegible] made with [illegible]

REFRACTING [illegible] Land [illegible]

ORRERIES and [illegible] the great [illegible] by himself [illegible]

The [illegible] all the Celestial Phænomena are [illegible]

In[illegible] FORTIFICATION [illegible]

GLOBES, mount[illegible] whereby the Phænomena of the Sun, Earth, M[illegible] [illegible]ted according to Nature [illegible]

GLOBES and SPHERES [illegible]

The FAMOUS [illegible] [illegible] of the Reverend Dr. [illegible]'s Invention, [illegible] Apparent Motion of the Heavens are most [illegible]d.

The SOLIDS in EUCLID'S ELEMENTS, with all their proper Sections cut in Wood; designed for the Ease of all Persons who would inform themselves demonstratively in the Practice of PERSPECTIVE, MENSURATION, SPHERICKS, &c. to be had only at the aforesaid Place.

AIR PUMPS, or Engines for exhausting the Air from proper Vessels, with all their Appurtenances; whereby the Properties of that most useful Fluid are discovered and demonstrated by undeniable Experiments; Engines for the Compression of the Air; HYDROSTATICAL BALANCES, nicely adjusted for determining the specifick Gravity of Fluids and Solids, &c.

Curious BAROMETERS, Diagonal, Wheel, Standard or Portable, with or without Thermometers. Also the so much famed QUICKSILVER THERMOMETERS, made after any of the Forms [illegible]

THEODOLITES of the latest Construction; WATER LEVELS, which may be adjusted at one Station, MEASURING W[illegible], Pocket and Coach WAY WISERS, for measuring the Way, &c.

MERIDIAN and AZIMUTH Sea Compasses of all Sorts, either for the Cabin, Steerage, or Pocket; artificial Magnets, particularly useful for touching Mariners Compasses.

SPECTACLES ground on Brass Tools, in the Manner app[illegible] by the ROYAL SOCIETY, set in Variety of conven[illegible] Frames. Also READING GLASSES of all Sorts, set in Silver or other Metal, [illegible] into Cases of various Kinds.

Prisms for demonstrating the Theory of Light and Colours.

The CAMERA OBSCURA, for Drawing in Perspective, [illegible] which [illegible] Objects are represented in their proper Colours, and [illegible]

[illegible] and CYLINDRICAL Looking Glasses, OPERA Glasses, [illegible] Glasses, SPECTACLES of the true *Venetian* Green Glass, MAGICK Lanterns, &c.

Z[illegible] for viewing perspective Prints.

N. B. Gentlemen may have any Model or Instrument made in Metal or Wood with Expedition and Accuracy.

FIGURE 345.

The Trade Card of George Adams, Mathematical Instrument Maker to His Majesty's Office of Ordnance, at the sign of Tycho Brahe's Head, at the Corner of Racquet Court, in Fleet Street, 17[illegible].

FIGURE 346.

The Trade Card of Henry Gregory, Mathematical Instrument Maker, at the sign of the Azimuth Compass, near the India Office in Leaden Hall Street, 1760.

in which John Dollond first "kept shop," is given in Figure 338, carried on business at the sign of the Quadrant, without the Old Bailey. He must have been a contemporary and neighbour of Nathaniel Hill, and so also were Benjamin Cole and Son, the orrery-makers at the Globe, in Naval historians cannot fail to be interested in the 1745 trade card of Robert Rust (see Figure 342), nautical instrument-maker at the corner of St. Catherine's Stairs, near the Tower of London. One of Rust's formidable rivals must have been Fisher Combes (see Figure 343), who carried on business in the same kind of scientific instruments at the sign of the Mariner and Globe in Broad Street, near the Angel and Crown Tavern, behind the Royal Exchange. It is somewhat difficult nowadays to understand the necessity of describing Broad Street as being in the vicinity of the Angel and Crown, or any other inn. The compass-card (1755) of William Watson (see Figure 344), of Church Lane Stairs, Hull, needs no explanation. It shews that the making of nautical and other scientific instruments was not a monopoly of the Metropolis. Henry Gregory (1760) was evidently another maker of nautical accessories (see Figure 346) who prospered in the very heart of London city.

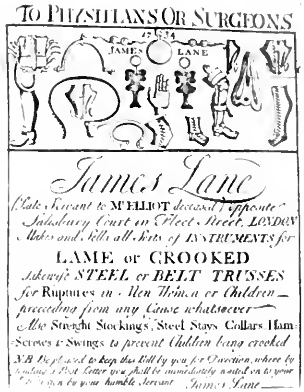


FIGURE 347.

Trade Card of James Lane, Maker of Surgical Appliances, Opposite Salisbury Court in Fleet Street, 1734.

Fleet Street, a vicinity then evidently largely patronised by instrument-makers of all kinds. John Bennett, who enjoyed the countenance and support of the Dukes of Gloucester and Cumberland, apparently adopted the same sign as Cole (see Figure 339), but considerably further westwards, *viz.*, in Crown Court, St. Ann's, Soho. John Bennett's card, shewing the details of early thermometers and weather-glasses (see Figure 340) is surmounted by the royal arms, and bears a strong resemblance to that issued by his neighbour, James Simons (see Figure 341), of the Sir Isaac Newton's Head at the corner of the now vanished Marylebone Street, opposite Glass House Street. In Simons' we have a sun-dial, and a microscope, besides a globe, telescope and orrery. Its date is 1785.

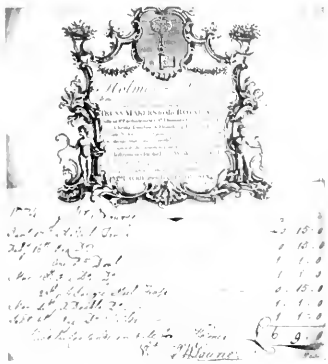


FIGURE 348.

Bill and Trade Card of Messrs. Holmes and Laurie, Makers of Surgical Appliances to the Royal Navy, at the sign of the Golden Key, in Bartholomew Close, West Smithfield, 1774.

FIGURE 349.

Bilingual Trade Card of John Chasson, a Surgical Instrument Maker, at the sign of the C and Cross in Newgate Street, cir. 1770.

FIGURE 350.

Bilingual Trade Card of Paston Cartwright, Surgical Instrument Maker, of Lombard Street, 1770.

etc.," at the sign of the Azimuth and Compass, near the India House in Leaden Hall Street. Gregory offers for sale all sorts of navigation books and sea charts, and advertises, amongst other things, Hadley's and Davise's Quadrants, Theodolites, Plain Tables, Gauging and Drawing Instruments and Telescopes at most Reasonable Rates."

The business card of George Adams, "Mathematical Instrument-Maker *to His Majesty's Office of Ordnance*" at Tycho Brahé's Head, the corner of Racquet Court, in Fleet Street, is an exceptionally interesting one. (See Figure 345.) It is difficult to understand Mr. Chancellor's omission of any mention whatever of the colony of scientific instrument-makers which formed one of the most interesting features of the Fleet Street of Johnson, Goldsmith and Boswell. The cards of the manufacturers of surgical appliances have been left to the last. The oldest of them all, James Lane, whose very curious trade card bears on the face of it in print, the date 1734 (see Figure 347), was also a Fleet Street worthy, with a shop opposite Salisbury Court in Fleet Street. He advertises "streight stockings, steel stays, collars, ham-screws and swings to prevent children being crooked." John Chasson, who issued a card with the text in both French and English (see Figure 349), lived in Newgate Street, at the sign of the "C. and Cross" (du C et de la Croix) concerning which the writer will welcome any explanation. Paston Cartwright (see Figure 350), in 1770, flourished amongst the bankers and notable merchants in Lombard Street, "near the Mansion House." He possibly enjoyed the support of the Lord Mayor, but, like Chasson, he found it advisable to use a bilingual trade card. Of all these eighteenth-century cards none presents more delicate artistic features than the bill-head of Holmes & Laurie, of Bartholomew Close, West Smithfield. (See Figure 348.) It is rendered specially interesting by the bill set out beneath it, which, receipted apparently by one of the heads of the firm, shows the exact date (1774), at which it enjoyed the distinction of being Truss-makers to the Royal Navy.

SOLAR DISTURBANCES DURING JUNE, 1912.

By FRANK C. DENNETT.

During the month of June, the Sun was apparently quite free from disturbance on eight days—3rd, 4th, 10th, 11th, 13th to 15th and 30th—whilst only faculae were seen on six—5th to 9th and 29th. The longitude of the central meridian at noon on the 1st was 311° 58′.

No. 7. A disturbance belonging to May which continued visible until June 2nd and accordingly re-appears upon the present chart.

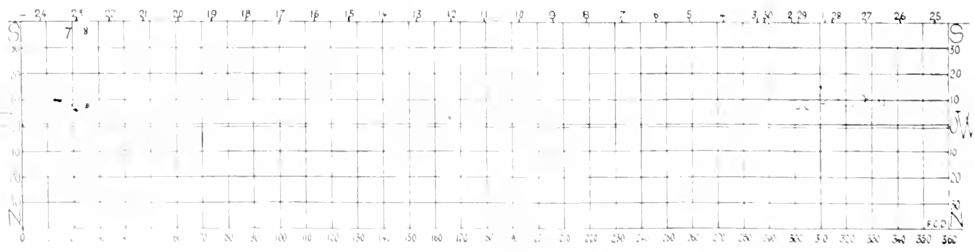
Upon the 12th a small pore was visible but its position was not measured; however, it could not have been far from 165° where a little cross is marked, although it may possibly have been upon the other side of the equator.

No. 8. A spot first seen on the afternoon of June 16th, close to the eastern limb, in south latitude 8°, and having a diameter of eleven thousand miles. During its transit across the disc the diameter at first increased to fifteen thousand miles; it also had a proper motion which carried it its own diameter nearer the equator. Nearly all the time it was visible the penumbra was noticed to brighten towards its inner border. The darker nuclei within the umbra were well shown. A tiny pore was suspected amid the bright faculae, which extended away toward the south-east on the 18th. A pore was also seen here on the 20th, whilst two were visible on the 23rd. The spot seemed to be shrinking somewhat when last seen a little within the western limb on the 28th.

Faculae were seen on June 5th in longitude 317°—327°, S. latitude 8°—14°; and on the 6th, the knot and streak at longitudes 301° and 305° degrees respectively. On the 8th, the disturbance in longitude 145°—152°, S. latitude 0°—7° was within the eastern limb. On the 18th, a bright knot was approaching the western limb in somewhat high northern latitude, and on the 19th, a small one near longitude 154°, at 54° N latitude. From June 21st until the 24th, faculae were seen from longitude 325° to 335°, S. latitude 8°—17°, and longitude 309°—312°, S. latitude 9°—15°, the return of the April disturbance. On the 29th, the faculic following of No. 8 was still visible within the western limb.

Our chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, C. Frooms, D. Booth, and the writer.

DAY OF JUNE, 1912.



THE FACE OF THE SKY FOR SEPTEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun R.A.	Sun Dec.	[illegible]	[illegible]	Mercury R.A.	Mercury Dec.	Venus R.A.	Venus Dec.	[illegible] R.A.	[illegible] Dec.	[illegible] R.A.	[illegible] Dec.	[illegible] R.A.	[illegible] Dec.
Greenwich Noon.	h. m.				h. m.		h. m.				h.		h.	
Sept. [illegible]	[illegible]	N. [illegible]	[illegible]	N. [illegible]	[illegible]	N. [illegible]	[illegible]	N. [illegible]	[illegible]	[illegible]	[illegible]	N. [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	N. [illegible]	[illegible]	[illegible]	[illegible]	N. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	N. 0 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	12 14	S. [illegible]	[illegible]	N. [illegible]	[illegible]	N. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N. [illegible]	[illegible]	[illegible]

TABLE 31.

Date.	Sun P	Sun B	Sun L	Moon P	Jupiter P	Jupiter B	Jupiter L_1	Jupiter L_2	Jupiter T_1	Jupiter T_2	Saturn P	Saturn B
Greenwich Noon.									h. m.	h. m.		
Sept. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	24 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4 24 [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11 [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	176	[illegible]	[illegible]	[illegible] m	[illegible]	[illegible]

TABLE 32.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T_1 T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $0^h\ 50\frac{1}{2}^m$, $0^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN moves South pretty rapidly. Sunrise during September changes from 5-13 to 5-59; sunset from 6-47 to 5-41. Its semi-diameter increases from 15′ 53″ to 16′ 0″. The autumnal Equinox is passed $23^d\ 10^h m$.

MERCURY is a morning star, well placed for observation early in the month. On September 1st, one fifth of disc is illuminated, semi-diameter $4\frac{1}{2}''$; on September 30th, the disc is fully illuminated, semi-diameter $2\frac{1}{2}''$.

VENUS is an evening Star, but too near the Sun for convenient observation. Illumination nearly complete, semi-diameter $5\frac{1}{2}''$.

THE MOON.—Last Quarter $4^d\ 1^h\ 23^m e$; New $11^d\ 3^h\ 48^m m$; First Quarter $18^d\ 7^h\ 55^m m$; Full $26^d\ 11^h\ 34^m m$. Perigee $9^d\ 6^h e$, semi-diameter 16′ 37″; Apogee $21^d\ 8^h e$, semi-diameter 14′ 46″. Maximum Librations, September 3^d, 7° E., 6^d 7° S., 15^d 7° W., 20^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h. m.		h. m.	
Sept. 3	τ^1 Arietis	5·2	1 30 *m*	88	2 44 *m*	215
,, 3	36 Tauri ...	5·6			0 4 *e*	298
,, 4	χ Tauri ..	5·3	4 45 *m*	22	5 35 *m*	302
,, 18	γ^1 Sagittarii ..	Var.	4 34 *e*	121	5 50 *e*	247
,, 19	BAC 6525	6·2	0 8 *e*	77	10 23 *e*	253
,, 22	37 Capricorni ..	5·7	6 18 *e*	131	6 51 *e*	181
,, 22	ε Capricorni ...	4·7	7 58 *e*	37	9 14 *e*	205
,, 22	κ Capricorni	4·8	11 51 *e*	78	0 50* *m*	218
,, 25	χ Aquarii ...	5·3	3 0 *m*	75	3 59 *m*	221
,, 25	24 Piscium ..	6·1	9 22 *e*	35	10 34 *e*	250
,, 28	BD – 12 271	6·3			6 44 *e*	205
,, 30	BAC 976	6·7			3 50 *m*	221
,, 30	ζ Arietis	4·8	6 3 *m*	77	7 8 *m*	250

TABLE 33. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

The asterisk indicates the day following that given in the date column.

MARS is an evening Star, but practically invisible.

[illegible] is an evening Star, [illegible] at distance from us, [illegible] the equat[illegible] diameter [illegible] from 19[illegible] [illegible]. The Polar [illegible]. The configurations of the [illegible] at 7^h [illegible] inverting telescope.

Day.	West.	East.		Day.	West.	East.	
Sept. 1	[illegible]	[illegible]		Sept. 16	321	4	
.. 2	[illegible]	4		.. 17	3	124	
.. 3	[illegible]	124		.. 18	31	24	
.. 4	31	24		.. 19	2	134	
.. 5	[illegible]	43		.. 20	2	31	1●
.. 6	4	13	2●	.. 21	1	243	
.. 7	41	23		.. 22	2	[illegible]	
.. 8	423	1		.. 23	3[illegible]1		
.. 9	4321			.. 24	[illegible]	21	
.. 10	43	12		.. 25	431	2	
.. 11	431	2		.. 26	42	1	3●
.. 12	42 ⊙	3		.. 27	421	3	
.. 13	4	3	2● 1●	.. 28	4 ⊙	23	
.. 14	4	123		.. 29	4 ⊙	13	
.. 15	2 ⊙	14		.. 30	2341		

TABLE 34.

Satellite phenomena visible at Greenwich. 1^d 6^h 43^m III. Sh. E.; 4^d 7^h 55^m I. Oc. D., 9^h 22^m II. Tr. I.; 5^d 7^h 26^m I. Tr. E., 8^h 44^m I. Sh. E.; 6^d 9^h 27^m 35^s II. Ec. R.; 8^d 8^h 17^m III. Sh. I.; 12^d 7^h 0^m I. Tr. I., 8^h 25^m I. Sh. I.; 13^d 6^h 51^m II. Oc. D., 7^h 47^m 56^s I. Ec. R.; 15^d 6^h 29^m II. Sh. E., 7^h 15^m III. Tr. I.; 20^d 6^h 17^m I. Oc. D.; 21^d 7^h 4^m I. Sh. E.; 22^d 6^h 22^m II. Sh. I., 6^h 41^m II. Tr. E.; 26^d 6^h 27^m 12^s III. Ec. D.; 28^d 6^h 44^m I. Sh. I., 7^h 49^m I. Tr. E.; 29^d 6^h 6^m 4^s I. Ec. R., 6^h 40^m II. Tr. I.

All the above are in the evening hours.

The eclipse reappearances of I. II. and both phases of those of III. occur high right of the inverted image, taking the direction of the belts as horizontal.

Mr. A. Burnet points out that the star ω Ophiuchi (magnitude $4\frac{1}{2}$) will be occulted by Jupiter on September 15th.

Disappearance about 9^h 25^me. Angle N. to E. 138°.

Reappearance .. 10^h 47^me. .. .. .. 257.

The disappearance may be seen from Lisbon, Rio or the Cape; the reappearance from Rio, La Plata or Cordoba.

SATURN is a morning Star. Polar semi-diameter $8\frac{1}{4}''$. The major axis of the ring is 44″, the minor axis $18\frac{1}{4}''$. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). September [illegible] *m.* 9^d $10^h{\cdot}5$ *e.* 17^d $11^h{\cdot}[illegible]$ *m.* 25^d $0^h{\cdot}9$ *m.* Dione [illegible] third given). September 2^d $8^h{\cdot}7$ *m.* 10^d $1^h{\cdot}8$ *e.* [illegible] $6^h{\cdot}8$ *e.* 26^d $11^h{\cdot}9$ *e.*

Rhea (every second given). September 1^d $2^h{\cdot}3$ *m.* 10^d $3^h{\cdot}2$ *m.* 19^d $4^h{\cdot}0$ *m.* 28^d $4^h{\cdot}8$ *m.*

For Titan and Iapetus, E., W. mean East and West elongations, I., S. Inferior and Superior Conjunction, Inferior being to the North, superior to the South. Titan, 5^d $6^h{\cdot}7$ *m* S., 9^d $10^h{\cdot}3$ *m* E., 13^d $11^h{\cdot}2$ *m* I., 17^d $7^h{\cdot}1$ *m* W., 21^d $5^h{\cdot}7$ *m* S., 25^d $9^h{\cdot}0$ *m* E., 29^d $9^h{\cdot}6$ *m* I. Iapetus 15^d $11^h{\cdot}8$ *m* I.

URANUS is an evening Star, semi-diameter 2″. It is $7\frac{1}{2}$° South of Alpha Capricorni, 5° South-West of Beta.

NEPTUNE is a morning star, but badly placed.

METEOR SHOWERS (from Mr. Denning's List):

Date.	Radiant. R.A.		Radiant. Dec.	Remarks.
June to Sept.	335	+	57	Swift.
July 25 to Sept. 15	48	+	43	Swift, streaks.
July to Sept.	335	+	73	Swift, short.
July to Oct.	355	+	72	Swift, short.
Aug., Sept.	353	+	11	Rather slow.
Aug., Sept	346	+	0	Slow.
Aug. to Oct. 2	74	+	42	Swift, streaks.
Aug., Sept	63	+	22	Swift, streaks.
Sept. 5—15	62	+	35	Swift, streaks.
.. 6—17	100	+	52	Swift, streaks.
.. 15—24	14	+	6	Slow.
.. 21	31	+	19	Slow, trains.
.. 27, 30	4	+	28	Slow.
Sept. 28 to Oct. 9	320	—	49	Slow, small.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
M. 15	21^h 26^m	N 11 °8	Cluster.
M. 2	21 29	S 1 °2	Cluster.
M. 39	21 30	N 48 °1	Cluster.
M. 30	21 36	S 23 °5	Cluster.
H VIII 75	22 12	N 49 °5	Cluster.

DOUBLE STARS. The limits of R.A. are 21^h to 23^h.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
Σ 2751	21 0	N 56 °3	6, 7	350°	2	White.
61 Cygni	21 3	N 38 °3	5, 6	128	23	Yellow.
5 Equulei	21 10	N 9 °7	4, 10	16	48	Yellow, blue.
The principal star is a very close double, period 5·7 years						
Piazzi XXI 51	21 11	N 59 °7	6, 7	222	1	White.
Lalande 41770	21 25	N 16 °7	$6\frac{1}{2}$, 6	205	$1\frac{1}{2}$	White.
β Cephei	21 28	N 70 °2	3, 8	250	13	Greenish, blue.
μ Cygni	21 40	N 28 °4	4, 5	122	2	Yellow, blue.
κ Pegasi	21 41	N 25 °3	4, 16	296	$12\frac{1}{2}$	Yellowish.
The principal star is a very close double, period 11·4 years.						
ξ Cephei	22 2	N 64 °2	$4\frac{1}{2}$, 6	283	7	Yellow, blue.
ζ Aquarii	22 24	S 0 °4	4, 4	310	3	Greenish.
37 Pegasi	22 26	N 4 °0	6, 7	140	[illegible]	White.
8 Lacertae	22 32	N 39 °2	6, 6	185	17	White.
Two other stars, mags. 8 and 10, belong to the system.						
Bradley 3128	22 48	N 61 3	6, 7	305	2	Yellow, ash.

TABLE 35.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

PROFESSOR J. C. KAPTEYN'S REPORTS ON THE PROGRESS OF WORK ON HIS SELECTED AREAS.—It will be remembered that a few years ago Professor Kapteyn made the suggestion that as the problem of finding the position, motion, spectrum and magnitude of every visible star was too vast for our resources, it would be well to select a series of small areas uniformly distributed over the sky, and that the stars in these areas should be studied with the greatest possible care. He anticipated that in this way most valuable data about the structure of the stellar universe might be acquired in a comparatively short time. He was fortunate in obtaining such a large measure of support for his plan that it is already well under weigh, and the reports now to hand take stock of the results acquired and make suggestions for the future. The work of organisation was felt to be beyond the power of one man, and a committee has been formed, consisting of Professor Kapteyn, Sir David Gill, Professors E. C. Pickering, G. E. Hale, F. Kustner, K. Schwarzschild, F. W. Dyson (Astronomer-Royal), and W. S. Adams.

The following are the positions of the selected areas.

The North Pole:—

Decl. 75 N.	R.A. 0^h 0^m	and every fourth hour.
Decl. 60 N.	R.A. 1 0	and every alternate hour.
Decl. 45 N.	R.A. 0 40	and every hour.
Decl. 30 N.	R.A. 0 25	.. .. ..
Decl. 15 N.	R.A. 0 10	.. .. ..
Decl. 0	R.A. 0 50	.. .. ..
Decl. 15 S.	R.A. 0 15	.. .. ..

And a similar continuation for the Southern sky.

The problem of finding accurate magnitudes is now undertaken far more carefully than it used to be, as very important questions of the structure of the universe and the possible absorption of light in space depend upon it.

The method mainly used is photographic, each region being photographed on the same plate as the standard polar area, the magnitudes in it having been determined at Harvard with the aid of some plates taken with the sixty-inch reflector at Mount Wilson, showing stars down to the twenty-first magnitude. A series of Durchmusterung plates of the selected regions is being taken by Professor E. C. Pickering, using originally the twenty-four inch Bruce telescope, focal length eleven feet, and subsequently the sixteen-inch Metcalf telescope, focal length seven and a half feet. These plates give tolerably good positions and accurate magnitudes and numbers of stars. They go down to the sixteenth magnitude, and contain about thirteen thousand stars per square degree in the Galaxy, which number falls to six hundred per square degree 60° from the Galaxy.

The next item in the work is a series of parallax plates of the selected regions. The Cape Observatory is active in this field in the Southern Hemisphere, and has taken one hundred and seventy-six finished plates.

Father Chevalier, at Zo-Sè (China) is undertaking a small region, and the Allegheny and Yerkes Observatories are also coöperating. At least two exposures are made on each plate six months apart, and either a third exposure six months later or a second pair of exposures on another plate (three exposures at half-yearly intervals being required to eliminate proper motion). These are all taken near the meridian, so that the effect of atmospheric dispersion, arising from slightly different colours of stars, is practically constant. This involves taking the region at about six o'clock a.m. at the first exposure, and six p.m. at the second.

PROPER MOTIONS.—A similar series of plates is being taken to obtain the proper motions of the fainter stars, but the interval must be at least ten years for useful results. It is proposed to keep the plates undeveloped, and re-expose after the interval; this, however, is not an essential, and a beginning can be made by comparing recent plates with those taken for the Carte du ciel ten or fifteen years ago. Besides the observatories mentioned above the Radcliffe Observatory, Oxford, is taking proper motion plates with the twenty-four inch equatorial, and photographs are being taken with the sixty-inch reflector at Mt. Wilson of the centres of the selected areas. The region of good definition on these plates is only 25′ across, but they will enable the magnitudes and countings, and in time the proper motions, to be extended to the eighteenth magnitude.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

VEGETABLE PROTEINS. Much interesting work has been done during the last few years on the proteins occurring in plants. These bodies are the most complex organic substances known, and they are of great importance from the fact that the protoplasm of plants and animals—"the physical basis of life"—consists essentially of proteins.

Zaleski (*Beih. Bot. Centralbl.*, Band XXVII, Abt. I) has studied the transformation of nitrogenous materials in ripening seeds, in their relation to the synthesis of proteins. He finds that various organic nitrogen-containing substances, simpler than proteins, are transformed to proteins during ripening. His method is to remove green peas from the pod and make determinations of the nitrogen in proteins, in amino-acids, and in organic bases; sets of young seeds are taken and treated in this way from time to time, part of each set being analysed at once, the rest after a week, and the analyses compared. In all cases considerable amounts of amino-acids and organic bases were transformed into proteins during storage of the seeds. In peas the synthesis was less than half as rapid in the absence of carbon dioxide as in its presence; drying of the seeds hastened the synthesis considerably.

According to Zaleski, the amino-acids resulting from the hydrolysis of a plant protein are the ones involved in its synthesis, the two processes being phases of a reversible reaction. This view is taken by various recent investigators, and is opposed to the older views that asparagin is the immediate material from which plant proteins are built up, or that proteins may be synthesised by the introduction of ammonia into simple organic compounds. Possibly the same enzymes (ferments) cause both the building-up and the breaking-down of proteins.

DEVELOPMENT OF LAMINARIACEAE.—As noted in these columns some time ago ("Knowledge," September 1910), it has been found that the so-called "zoöspores" of *Laminaria*, the "sea tangle," are in reality sexual cells (zoögametes) which fuse in pairs, the resulting fusion-cell (zygote) producing a chain or mass of cells from which the *Laminaria* plant arises.

Killian (*Zeitschrift für Botanik*, III) has made a thorough investigation of the early growth of *Laminaria* from the confervoid protonema stage, and has also brought together the scattered though extensive literature of the Laminariaceae, adding many interesting observations of his own regarding the anatomy, regeneration, and general biology of this group. He finds that from the primary few-celled protonema there arise secondary protonemata which for a time undergo repeated cell-divisions in all directions and remain at first uniform in structure but later there is localised growth and specialisation of the tissues. All the tissues are genetically connected together. The inner tissues are distinguished by their feeble power of growth and division, hence they play a passive part and their original arrangement undergoes disturbance; the primary connections between these inner tissues are lost, and new tissue-elements are interpolated from the outer zone. The Laminariaceae agree closely in histological structure with the Fucaceae. All parts of a *Laminaria* plant respond rapidly to wound stimuli, regeneration being quickly and completely effected when these parts are injured by cuts [illegible] in all [illegible] to the [illegible] of the [illegible].

[illegible] *of Botany*, XXV [illegible] investigated the early [illegible] species of *Laminaria*, *Costaria*, and *Undaria* [illegible] considerably to previous records regarding the [illegible] to adult plant in the Laminariaceae. The [illegible] filamentous, growing by a single apical cell, the [illegible] division occurs in the youngest segment (the [illegible] below the apical cell) and the two cells thus formed [illegible], grow so that the upper part of the plant [illegible] a [illegible] layered expansion, supported on a [illegible] stalk. By further divisions, the expanded portion or blade becomes two-layered, while the stalk becomes a cylinder consisting of several rows of cells, while a meristematic, or actively growing and dividing, zone appears at the junction between blade and stalk. Apical growth gradually diminishes as development proceeds, and finally ceases. A single "pre-cortical" layer of large cells is developed at the transition region, between the already existing two layers; then this pre-cortex grows in thickness and sends inwards thread-like outgrowths which give rise to the loose central tissue or medulla.

CHEMISTRY.

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

SENSITIVENESS OF BIRDS AND MICE TO CARBON MONOXIDE.—A *Technical Paper* by Mr. G. A. Burrell, has just been published by the Bureau of Mines, Washington. It is shown that the production of a cap upon the flame in a safety lamp is not a reliable method of detecting the presence of carbon monoxide in the gases in mines after explosions or fires. A more sensitive means is to test the air with cuprous chloride solution or with blood solution, though both of these are inferior to the use of mice or small birds as indicators. As an example, it is mentioned, that on one occasion Mr. Burrell himself had remained for over twenty minutes in a room, the atmosphere of which contained 0·25 per cent. of carbon monoxide, and at the time experienced no ill-effects beyond a slight headache, although subsequently he became ill; whereas canaries under the same conditions showed indications of distress within a minute and fell down within five minutes. Mice are also much more sensitive than human beings to the action of the gas, though they do not show the effects so soon as birds. The method has already shown its value in practice, as is shown by the following instance. A number of persons exploring a mine took with them a canary, and on reaching a certain place the bird fell from its perch. The party at once retreated without having suffered ill-effects, although a subsequent analysis of the air at this spot showed that it contained from 0·25 to 0·3 per cent. of carbon monoxide.

ACTION OF ACIDS ON CONCRETE.—The cause of the rapid disintegration of concrete drains (in many cases soon after they have been laid) has been investigated by Dr. E. Neumann (*Tonind. Zeit.*, 1912, XXXVI, 601). The results of the experiments showed that in every instance the concrete had been acted upon by an acid, either from without or within. Thus, in one case the soil in which the concrete was laid contained iron pyrites, by the decomposition of which in the presence of the water in the soil, sulphuric acid was produced. In other cases sulphuretted hydrogen within the drains became partially oxidised to sulphuric acid. Other acids, such as acetic, hydrochloric or oleic acid, also act upon concrete, though these are not likely to be of such common occurrence as sulphuric acid. The latter appears to produce its injurious effect by decomposing the aluminium and calcium compounds in the concrete to form sulphates (especially calcium sulphate), and in the production of these a considerable increase in the volume of the material takes place. Acids also act by converting some of the constituents of the concrete into soluble salts, notably calcium bicarbonate, which are then gradually dissolved by the water, so that the material falls to pieces.

A[illegible] remedy it [illegible] that the concrete should be made [illegible] and [illegible] as possible, and that the foundations of the drainage [illegible] exposed plates should be protected with asphalt or tar. In addition to these external precautions means must be provided for the effective ventilation of the interior.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

A FORMER COURSE OF THE THAMES.—An interesting suggestion as to a former course of the Thames is made in a paper by Dr. R. L. Sherlock and Mr. A. H. Noble in *The Quarterly Journal of the Geological Society* for June, 1912. They also deal with the clay-with-flints of Buckinghamshire, which they believe to be of glacial origin. They regard it as representing the product of the waste of ages of the chalk and Eocene outliers, swept up by an ice-sheet from the north or north-west, and spread out as the incoherent material spoken of as the "clay-with-flints." If the chalk solution theory of its origin be regarded as disproved, the glacial theory is the only one consistent with the general character of the deposit and the unworn nature of its flints. The clay-with-flints is accompanied by a glacial gravel consisting entirely of flint. It must be distinguished from the fluvioglacial or plateau-gravels generally lying at a lower level and characterised by containing a certain amount of material from distant sources. The plateau gravels lie to the south and south-east of the clay-with-flints area. The far-travelled pebbles occur abundantly in a belt three to four miles wide, running parallel with and including the present valley of the Thames from Hurley to Bourne End, continuing in the same east-north-east direction through Beaconsfield and Chalfont to the Colne valley. These pebbles must have been brought into their present position by the Thames, and their distribution seems to point to a former course of the Thames at the foot of the Eocene escarpment from Bourne End to Rickmansworth, and from thence to Watford along the line of the Colne, which occupies a part of the old valley. The level of the gravels and the number of far-travelled pebbles fall off from the Thames towards Watford, and thus afford corroborative evidence for this view. The diversion of the Thames towards the south at Bourne End is believed to have been accomplished by the movement of the ice-sheet across the old Thames valley, forcing the water to escape over a col by way of Maidenhead.

Pertinent criticism in the ensuing discussion turned upon the definition of clay-with-flints and whether all clay-with-flints (for example, that of Surrey) was to be regarded as of glacial origin. The question was also asked whither the authors proposed to send the Thames after it had reached Watford—a question they preferred to leave unanswered until they had examined the country east of Watford.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended June 15th, as set out in the Weekly Weather Report issued by the Meteorological Office, was very unsettled, with frequent rains. Thunderstorms were reported on each of the first five days of the week, and these were in many cases accompanied by heavy rain or hail.

Temperature was below the average in all districts except England, E., but the variation was nowhere very great. The highest readings reported were 73° at Cullompton and Camden Square, and 71° at Greenwich and Southampton. At Lerwick the maximum for the week was only 52°, and at Wick 55°. In Guernsey the maximum was 66°. The lowest readings were 37° at Llandrindod Wells, and 39° at Cahir, Markree, and Marlborough. On the grass the lowest readings reported were 31° at Birmingham, and 33° at Buxton and Dublin (Phoenix Park).

The temperature of the soil at one foot depth was below the average very generally; at a depth of four feet it was almost normal.

Rainfall was in excess in all districts except the English Channel, where it was only half as much as usual. In many parts of the Kingdom, however, it was more than double, and in England, N.E., it was nearly three times the average. At Alnwick Castle the total for the week was 2·36 inches or more than five times the average amount, 0·44 inch.

Sunshine was above the average in England, E., S.E., the Midland Counties and in Ireland, S., but below it elsewhere. The variations were somewhat remarkable, England, E., having the largest daily average, 8·2 hours (50%) and Scotland, E., the smallest daily average, 1·3 hours (7%). In the one case the daily value was 1·7 hours above the average; in the other case it was 4·6 hours below it.

The mean temperature of the sea water varied from 48°·2 at Berwick to 59°·7 at Margate and Seafield.

The weather of the week ended June 22nd continued very unsettled in the West and North, with frequent heavy falls of rain. Over the south-eastern counties, however, the weather improved after the 17th. Thunderstorms were reported on the 16th, 19th, and 22nd.

Temperature was above the average in the greater part of England and in the English Channel, but was below it in Scotland and Ireland. The excess was greatest in England, E., where the district value was 60°·3 as compared with the average of 57°·8. Some very high temperatures were recorded during the week, the highest being 84° at Greenwich, 83° at Hampstead and Camden Square and 82° at Tunbridge Wells. The lowest of the minima were 35° at Balmoral and 37° at West Linton, Poltolloch and Kilmarnock. Ground frost was reported at Crathes (29°), Newton Rigg (30°) and Balmoral and Glasgow (32°).

The temperature of the soil at one foot depth was above the average at most of the English stations, but below it in Scotland and Ireland. At a depth of four feet it was very close to the normal.

Rainfall was in excess except in England, E., S.E., the Midlands and the English Channel. In Scotland, W., and in Ireland the total precipitation was about three times as much as usual: in England, S.E., and the English Channel it was less than one-third the average.

Bright sunshine was in defect except in England, E. and S.E. The district values varied from 8·5 hours (51%) in England, E., to 2·5 hours (15%) in Ireland, S. The sunniest stations were Greenwich with a daily average of 9·2 hours (56%) and Southend 9·1 hours (55%), while at Balruddery near Dundee the value was only 1·9 hours (11%). At Westminster the average daily duration was 8·3 hours (51%). The mean temperature of the sea water ranged from 49°·4 at Lerwick to 61°·9 at Margate.

The weather of the week ended June 29th was generally cool and unsettled, with much rain and many thunderstorms. Temperature was above the average in Scotland, N., and England, N.E. and E., but below it in all other districts except Scotland, E., where it was normal. The extremes recorded, however, were neither so high nor so low as in the preceding week, the highest readngs recorded being 78° at Margate, 76° at Greenwich, and 75° at Gordon Castle, Yarmouth, Geldeston, and Camden Square; and the lowest 40° at Balmoral, and 41° at West Linton. No frost on the ground was reported, the minimum on the grass being 34° at Crathes and at Hampstead.

The soil temperature at one foot depth was above the average: but at four feet depth the excess was small, and in some parts of the country it was slightly in defect.

Rainfall was in excess in all districts except Scotland, N., where it was in defect.

In England, S.W., and in Ireland, S., the totals were more than three times as much as usual. At Arlington, N. Devon, the amount collected during the week was 3·46 inches, as compared with an average of 0·78 inches. At Westminster the total did not quite reach half an inch.

Sunshine was in defect very generally, but in England, S.E., and the English Channel it was slightly above the average. The sunniest district was the English Channel with a daily average of 8·8 hours (55%), while in Scotland, N., and Ireland, N., the mean daily value was only 3·9 hours (23%). The sunniest stations were Guernsey, 10·2 hours (64%), and Weymouth 9·2 hours (57%).

The temperature of the sea water round the coasts ranged from 50° at Lerwick and Berwick, to 63° at Margate and Teelin, and 66° at Seafield.

FIGURE 351.
The six-legged stage of a Harvest Mite × 150 diameters.

MICROSCOPY.

By F.R.M.S.

HARVEST - MITES.—The hot dry days of last summer were particularly favourable to these minute pests, and holiday-makers in many districts must have suffered from their attacks, probably without ever catching sight of their tormentors. Harvesters or harvest-bugs are a species of grass-mite; they are bright red in colour, and the body alone is about one seventy-fifth of an inch long. The photomicrograph shows the six-legged stage magnified one hundred and fifty times. It will be seen that it has rather a formidable-looking beak, and that its legs, which are about as long as its body, are each armed with three claws. The mites are difficult to detect on the human skin, but can be easily seen on a sheet of white paper; specimens can be obtained by putting a sheet of paper under long grass and beating the grass with a stick. The harvesters will be seen as quickly-moving red specks, and can be caught on the tip of a fine camel's hair brush previously moisted with water or spirit.

ERNEST MARRIAGE, F.R.P.S.

LOW POWER PHOTOMICROGRAPHY—LIGHTING AND BACKGROUNDS.—In photomicrography generally, and perhaps especially in the domain of low power work as used by naturalists, I would be inclined to say that success, like a three-legged stool, depends on three supports, *viz.*, (1) focusing, (2) lighting (including backgrounds), (3) exposure and development.

In this note I propose, as briefly as may be, to offer a few general suggestions on the topic of lighting and backgrounds, for the benefit of the busy worker who wants to get at the heart of the matter as directly as possible in its practical application, and without going through the mill of trial and error. At the same time, be it said, to anyone disposed to make a few quite simple experiments the slight trouble involved would be well repaid.

With a view to simplifying matters I select four small shells, which are here shown magnified about three diameters, to illustrate four typical classes of such subject.

On our right is a *smooth*, shiny, white shell (A); to the extreme left a yellowish-gray, *rough* shell (B); at the top a moderately smooth surfaced specimen, showing red and yellow *markings* (C); below a specimen having a slightly ribbed surface, and also a portion where the outer layer has broken away, laying bare the *iridescent* nacreous layer (D).

By a pin's head touch of seccotine these specimens are affixed to a piece of matt surface (so called) black paper, which in turn is pasted on to an ordinary micro-slip.

It is not unnatural to think the stronger the light the better will be the result. Figure 352 shows the effect of a strong direct sunlight falling sideways on the object from a narrow window on our left. In this case we get a loss of detail in the strongly-lighted parts and intense cast shadows, both undesirable features; but we may note where this sidelight catches small prominences, in B or D, for instance, we get the contrast effect due to cast shadow—a point worth remembering for occasional use. Moving the object just out of the path of direct sunlight, yet retaining side illumination, we get the effect shown in Figure 353. Again the contrasts are strong, but the shadows are not so sharply defined. On the whole this scheme of lighting is preferable to the first method, as it gives us the one advantage of the first method without its two other disadvantages. This print has purposely been made rather too contrastful by over-developing the negative, with the idea of drawing attention to this very general fault with this lighting.

In the next example (Figure 354) the apparatus was revolved so that the window lighting was midway between a "side" and a "back" lighting. It may be noted that the cast shadows on the background are less wide than in the second position; the surface details in B and D are better rendered in every way by delicate contrasts of light and shade; the roundness and surface-glinting, reflecting light of A indicate its form and surface. Colour contrasts in C are here better shown. All things considered, this is the most generally useful lighting apart from special effects required. Figure 355 gives us the effect of light from a large window falling on the object from behind, *i.e.*, over the top and at both sides of the camera. This is a very common, but very seldom satisfactory, plan.

Figure 352.

Figure 353.

Figure 354.

Figure 355.

The common notion is "the more light the better," but one may recall the pregnant saying of William Hunt, the artist, "There is only one way to have light. Have darkness to make it on. Nothing exists without a background." Most photographers when photographing a cathedral or even a human being recognise the necessity for both light *and* shade, but when dealing with little things shade is forgotten. Flooding a small object with light does not necessarily bring out character. In Figures 354 and 355, for example, we may compare the rendering of the delicate surface ribbing on specimen D, noting how the shadows cast by these ridges in Figure 354 show far more character than in the back-lighted example (Figure 355).

Doubtless the reader has noted that I said we were here using matt surface, *i.e.*, non-shiny black paper, but that in the accompanying figures the background looks rough, coarse-grained and anything but uniformly black. One may notice that in Figure 352 we get a very noticeable difference between the sunlit and cast shadow parts of this black paper. As one would naturally expect, we get least granulation with a back lighting, Figure 355, when the incident light falls into the tiny valleys of the paper surface, and most surface indication in Figure 352 when the strong side light throws cast shadows from the little elevations of the paper surface. It should not be forgotten that while we are enlarging the images of the shells we are at the same time enlarging the surface grain of the paper. And, further, when this background is in fairly sharp focus, one is tempted to notice this enlarged granularity. Later on something further may be said about focusing and definition, but not to distract the reader's thoughts from the lighting topic it may suffice for the moment to say that our general aim should be to get the object in sharp focus but to let its background be slightly *less* sharply defined. This for two reasons. The difference of definition helps the idea of different distances and so aids modelling, relief, and roundness. Also, as the eye naturally is attracted by those parts of the picture which are in sharpest definition, the sharply focused object gets more eye attention than the less sharp background, which is as it should be. The beginner will find it a great help in choosing his scheme of lighting to view the object from just over the top of the camera and looking at it through a piece of rough black paper rolled up to form a viewing tube when held close to one eye.

F. C. Lambert, M.A., F.R.P.S.

PHOTOGRAPHY.

By Edgar Senior.

THE USE OF PROJECTION OCULARS IN PHOTO-MICROGRAPHY.—In our article on low power photo-micrography in the June issue of "Knowledge," we showed examples taken by means of the objectives only, making use of the extreme camera extension available, "one hundred and sixty-three centimetres," in obtaining the magnifications given. If, however, it be desired to still further increase the size of our image, in order to render visible detail too small to be readily seen by the unaided eye, then resort must be made to the use of an ocular ("eye-piece") as well. A deal of diversity of opinion exists as to whether the ordinary oculars employed for visual observation should be used in photographing. We ourselves have obtained excellent results with them. For great magnification, the compensating oculars used in conjunction with apochromats will be found to work well with modern achromats. There can be no doubt, however, that wherever possible it will be advisable to employ a projection ocular, for although primarily intended for use with apochromatic objectives, they give excellent results with achromats. This eyepiece consists of a collective lens, and a triple projection combination at the other end of the tube, and the former, "when the specimen is in focus," forms, in combination with the objective, an image of the object in the plane of the eyepiece diaphragm. The edge of this diaphragm is then sharply focused upon the ground glass screen by means of the focusing collar in which the projection lenses are set. If attention be paid to this, an exquisitely sharp image should result. One drawback to these oculars lies in the great restriction of the field, so that it is impossible to use them for any object at all large. The illustration (see Figure 356) is from a negative taken with a one-inch objective of Messrs. James Swift & Son, together with a four-projection ocular of Messrs. Zeiss. The magnification due to the objective alone was eighty diameters, and this multiplied by four, "the value of the ocular," gives a total magnification of three hundred and twenty diameters, due to the combination of objective and eyepiece together. The exposure given was six minutes, calculated from the square of the increased magnification due to the eyepiece. The plate employed was an Imperial N.F. of speed two hundred and twenty-five H and D, and a green screen was used, as before, to give greater contrast. The negative was developed with pyro and soda developer, containing one grain of potassium bromide in each ounce of solution.

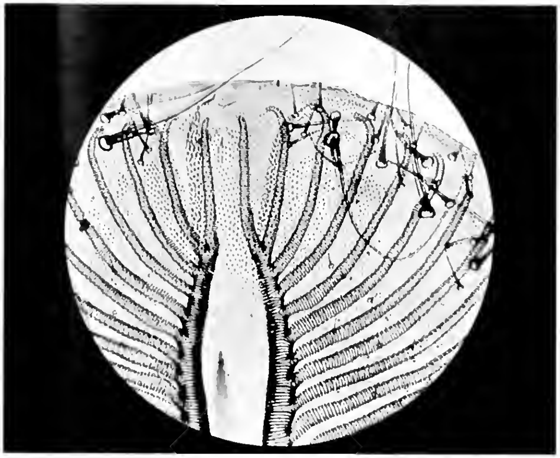


Figure 356. Portion of the Proboscis of a Blow-fly.

Photographed with Swift & Son's 1-inch objective and a 4-inch projection ocular of Zeiss. The original was magnified 320 diameters, and is reproduced half-size.

PROCEEDINGS OF THE OPTICAL CONVENTION. I.—COLOUR PHOTOGRAPHY.—A paper entitled "The micro-spectra method of colour photography," by Julius Rheinberg, F.R.M.S., deals with a means of producing images in the colours of the objects by photography, without the use of colour screens, coloured pigments or particles, or any device of this nature. It is a one plate, one exposure method, the image, which is black and white, being developed in the ordinary manner. The principle is one of optical synthesis, in which the blending of spectrum colours produces the sensation of white light upon the retina, when if by any means the proportion in which the colours are mixed be altered, the resulting effect is no longer of white but of colour. The method that has been adopted to carry out practically the principle involved, is most ingenious. It is well known that if a narrow slit in an otherwise opaque screen be illuminated by white light and an image of it focused upon a screen, the interposing of a prism results in the formation of a spectrum image of the slit, but if instead of a single slit a number be employed, then a number of spectrum images results. The authors of this process of colour photography have taken advantage of this in designing a screen, having four hundred slits per inch, the ratio of which to the opaque spaces is in the proportion of one to three, and by the use of a prism with small dispersion they have been able to obtain a distinct and separate spectrum with each slit. The photographic objective used in the camera magnifies the images of the slits four times. The result is a series of regularly repeating spectrums side by side, without any intervening gaps between them, and practically without any overlap, of one hundred per inch. And since the individual colours cannot be separately distinguished the sensation of white light results from their optical combination. In taking a photograph, the image of the coloured object is projected on to the line screen by means of a lens; the line screen and image are then focused on to the ground glass screen of the camera by means of a second lens with the analysing prism in front of it. The plate employed in taking the negative must, of course, be a panchromatic one. From the negative obtained, a positive transparency is made, and this, when placed in the camera "in the exact position occupied by the negative and illuminated by white light," will, by means of the deposit of silver forming the image, so remove from the white light those constituents not active in taking the negative image that the remainder will impart the colours necessary. If, for instance, red and green light had impressed themselves in the negative, these parts would be transparent in the positive, and the red and green would optically form yellow. This process of colour photography appears to be a most fascinating one. The paper is full of the most interesting problems, and the authors deal at some length with the various difficulties encountered. A normal spectrum such as is given by a diffraction grating was desirable, and a prism to give this result was computed by Mr. Conrady, of Messrs. Watson & Sons.

II.—PHOTOGRAPHIC LENSES.—In a paper on the transmission of visible light by photographic lenses, by R. W. Cheshire, B.A., the author occupies himself with some experiments carried out at the National Physical Laboratory, on the loss of light due to reflection and absorption by the glass composing the objectives. For a surface that has not been recently polished the amount of light reflected normally was found to be [illegible] per cent. But it was to the loss due to absorption of light by the glass composing the lens that the experiment was mainly directed, and it was thought that it might be possible from the results obtained to establish a general empirical formula, by which the transmitting power of a lens might be estimated merely from a knowledge of the number of glass-air surfaces in the lens, and the axial thickness of the glass from which it was made.

The method employed was to compare photometrically the intensities of two beams of light: in the one case when the photographic lens to be tested is inserted in the path of one of them, and in the other when the lens is withdrawn. The source of light was a Nernst lamp, the filament of which was focused upon a small circular opening placed at the principal focus of an achromatic telescope objective of about eighty centimetres focus. This gives a parallel beam of light which falls upon one side of the diffusing screen of a Lummer-Brodhun photometer. The other side of this screen is illuminated by means of a glow-lamp enclosed in a light tight box. In order to counteract the yellowness of this glow lamp, a circular disc provided with openings carrying a number of tinted glasses which are able to be rotated in front of the lamp is provided, and by this means the colours of the two light sources can be matched. When taking readings, the lens to be tested is placed on a support, and an auxiliary lens (employed to obtain a patch of light of a convenient size) moved along in its holder until a circular patch of light of a useful size is obtained on the diffusing screen of the photometer. The distance of the comparison lamp (glow lamp) is then adjusted until the field of view seen through the photometer is symmetrically illuminated. Several readings are taken and the mean distance of lamp from the screen noted. The lens to be tested is then removed and a similar set of readings taken with the auxiliary lens in position only: whose effect may be neglected, since it is present in both cases. From results obtained, tables have been made showing the percentage transmission of light for twenty-four objectives tested. These tables are arranged under four headings according as the number of glass-air surfaces are four, six, eight, or ten. The author also points out that the percentage transmission in any particular case can be found approximately by the following rule. For each glass-air surface allow for the loss due to reflection 5·22 per cent. of the light incident on that surface, and for the loss due to absorption allow 2·4 per cent. of the light incident upon the lens for each centimetre of the axial thickness of the glass composing the lens. The following is given of a case in point: Consider a lens having eight glass-air surfaces in which the total axial thickness is 2·8 centimetres. At each glass-air surface 5·22 per cent. of the light is reflected and 94·78 per cent. only transmitted. Therefore, if reflection only were the cause of the loss of light, the amount transmitted would equal $(\cdot 9478)^8$ of the incident light, or 65·1 per cent. But there is the loss due to absorption as well, which in this case amounts to "2·8, the thickness in centimetres, × 2·4 per cent., the loss due to absorption of the light incident upon the lens," and this amounts to 6·7 per cent. The final value of the transmitted light, therefore, amounts to only 58·4 per cent., *i.e.*, 65·1 − 6·7. The author states that the observed value was 58 per cent., the error, ·4, being due to the difference between the percentage transmission calculated by this rule and that actually observed. The paper is a most valuable one, and will be found well worth careful consideration by those interested in the subject.

III. PROOF PLATES. An interesting exhibit of test plates used in checking the polishing of lens surfaces and made to an accuracy of 1/4000 of a millimetre was exhibited by Messrs. J. H. Dallmeyer, Ltd., of Denzil Road, Neasden; those used in testing plane surfaces showing broad bands instead of wide rings. The same firm also showed the various stages through which their well known stigmatic lens passes during the course of manufacture, as well as finished examples of their series II, stigmatics, which really comprise four lenses in one, for they can be used complete as a rapid anastigmat, and the single components are corrected for use alone, each giving a picture on a larger scale than the complete lens. And, further, as the latter can be used successfully on a larger plate, it becomes a wide angle lens as well. There were shewn the latest fixed focus telephoto lenses working with large apertures, so permitting of instantaneous exposures and giving images from two to five times that given by ordinary lenses at the same extension, e.g., the Adon, a small complete telephoto lens covering plates up to fifteen inches by twelve inches, and giving magnifications of from two to four, six, ten and higher diameters. An iris diaphragm shutter of maximum opening, showing the greatest aperture it is possible to obtain consistent with closing in this form, after a paper communicated to the Optical Society by Cyril B. Lan-Davis, F.R.P.S., was on view. The maximum opening theoretically obtainable is 88 per cent.; with this form, 76·5 per cent. of the total diameter is utilised. The same firm also exhibited a series of large prisms, in one of which the effect of uneven cooling was distinctly visible as striae or veins. On Saturday, the 22nd of June, a number of members of the Convention visited Messrs. Dallmeyer's works, and were greatly interested in seeing the various processes through which photographic and other lenses pass, and the methods employed in the manufacture of optical instruments. The party included Messrs. F. B. Vinycomb, Alex Mackenzie, B. H. Parker, J. Hartley Perks, James Robert Milne, James Grundy, J. W. Ogilvy, A. E. Charlton, F. W. Edridge-Green, C. B. D. Macklow, and Mrs. C. Macklow.

EXPOSURE TABLE FOR AUGUST.—The calculations are made with the actinograph for plates of speed 200 H and D, the subject a near one, and lens aperture F.16.

Day of the Month	Condition of the Light.	Time of Day: 10 a.m. and 2 p.m.	8 a.m. and 4 p.m.	6 a.m. & 6 p.m.	5 a.m. and 7 p.m.
Aug. 1st	Bright	·09 sec.	·13 sec.	·3 sec.	·63 sec.
,, ,,	Dull	·18 ,,	·27 ,,	·6 ,,	1·27 ,,
Aug. 15th	Bright	·1 sec.	·15 sec.	·42 sec.	1·8 sec.
,, ,,	Dull	·15 ,,	·3 ,,	·82 ,,	3·7 ,,
Aug. 30th	Bright	·12 sec.	·18 sec.	·6 sec.	3·3 sec.
,, ,,	Dull	·24 ,,	·36 ,,	1·2 ,,	6·6 ,,

Remarks.—If the subject be a general open landscape, take half the exposures given here.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

THE CHEMICAL EFFECT OF X-RAYS.—The ultra-violet rays are well-known to have considerable effect in causing chemical changes to take place; there are many instances of isomeric change: of oxidation and reduction which take place more rapidly under the influence of these rays. It is interesting to find, therefore, that the X-rays have similar effect. Dr. Russ and Mr. Colwell have found that starch solutions are slowly converted into dextrin under the action of the X-rays. Kernbaum has found that X-rays do not decompose water, like the rays of radium are found to do, producing hydrogen and oxygen, so that the effect of the X-rays on the starch molecule must be a direct one.

Sir William Ramsay has confirmed the result that niton (or radium emanation) produces neon and helium in presence of water, both by direct experimental evidence from the analysis of gases pumped off from water exposed to a dose of niton for two years and also by the observational evidence that Bath waters, which are radio-active, contain a very large quantity of neon compared with the quantity of argon present; the gases from the waters of Bath contain a considerable quantity of helium also, but an even larger quantity of neon.

It is an exceedingly interesting fact that the decomposition of niton in solution gives niton and helium, while in solid minerals, and so on, it only gives helium. Is the niton a kind of polymerised helium? or is it produced by the action of charged helium atoms on oxygen of the water? These are questions which are immediately raised by this interesting work.

THE NATIONAL PHYSICAL LABORATORY.—Volume VIII of the "Collected Researches of the National Physical Laboratory at Bushey Park" contains many researches of great interest and high value. Dr. Kaye has succeeded in constructing a standard metre of silica. Dr. Stanton has measured the shearing stress in the flow of air through pipes at speeds which cause the air to be in a turbulent condition, and the frictional resistance at the surface to be proportional to the square of the velocity. Dr. Rosenhain and Mr. Archbutt have carried out an interesting research on the alloys of aluminium and zinc which prove to be very complex. Messrs. Melsom and Booth have investigated the heating of electric cables, which work will be valuable commercially. Dr. Harker and Mr. Higgins have investigated the methods of taking the "flash point" of oils, and find that the temperature of the oil and vapour interface is the important factor. The results of work with the Froude water tank and the frictional resistance of air connected with matters dealing with stability of ships and aeroplanes are advancing satisfactorily. The visibility of lights, electrical measurements, specific heat of metals, and many other subjects, are included in the work of the laboratory as set forth in the Report.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

STRANGE HOMES FOR EARTHWORMS.—In searching for Lumbricidae on the Alps, Dr. Robert Stäger followed the useful plan of looking in unlikely places. In the mossy cushions which often flourish on the stem and branches of the sycamore (*Acer pseudoplatanus*) and bear ferns and various flowering plants, he found four species of earthworms,—*Helodrilus (Dendrobaena) rhenani* Br., *H. rubidus* Sav. and the variety *subrubicundus* Eisen, *Lumbricus rubellus* Hoffm., and *Eisenia alpina*. In cushions formed on almost bare rock by plants like *Dryas octopetala*, *Silene acaulis*, and *Gypsophila repens*, he found other earthworms. His facts afford interesting illustrations of the insinuation of life into every vacant niche.

TEETH OF SHREWS.—It is well-known that ordinary placental mammals with various types of teeth (heterodont, that is to say) never have more than three pairs of incisors. Thus there is a gap between them and the old-fashioned Polyprotodont Marsupials, such as the Tasmanian Wolf or Thylacine, which has four upper incisors, and the Bandicoot (*Perameles*), which has five. A recent study of the development of the teeth in Shrews by Augusta Arnbäck-Christie-Linde has revealed many interesting points, one of which is the presence of more than three incisor germs in both jaws of *Sorex araneus*, and probably also in the upper jaw of *Neomys*. These extra incisor germs in the Shrew are vestigial structures without any function; they disappear without attaining full development. "They are undoubtedly inherited from distant ancestors, which consequently were to be found among polyprotodont (and heterodont) mammals." In fact, it seems as if the Shrews bridged the gap alluded to.

FAUNA OF BURROWS.—Of recent years considerable attention has been paid to the various tenants of the burrows made by moles and hamsters and other mammals of similar habit. L. Falcoz suggests a classification of the burrow-fauna into (1) "Pholéobies," which live and develop exclusively in burrows (2) "Pholeophiles," which are often found in burrows but elsewhere as well, and (3) "Pholéoxènes," whose presence in burrows is accidental. He regards the burrow-fauna as leading on to a cavern-fauna. In burrows of mole and badger he has found numerous beetles and flies, not including parasites belonging to the burrower and occasional inmates. The Myriopods, Arachnids, and Thysanura which abound in the mole's nest in winter are occasional guests, except perhaps the notably lucifugous species *Lephthyphantes alutacius* E. Sim, *Chelifer phaleratus* E. Sim, and *Japyx solifugus* Halid. As true members of the burrow-fauna may be mentioned the Staphylinid beetles, *Heterops praevia*, *Oxypoda longipes*, *Aleochara spadicea*, common in the abode of moles, likewise the Silphid beetle *Catops nigrita* and the Dipterous fly *Lycoria nervosa*.

SMELL IN FISHES. It is probable that different fishes are attracted to their food in different ways, some being appealed to by the eye chiefly, others being susceptible also to odours and chemical stimuli. Professor G. H. Parker, has made many interesting experiments with the common American Killifish (*Fundulus heteroclitus*) which show that in this case smell counts for much. He wrapped up pieces of dogfish in cotton cloth, and the Killifishes in the aquarium competed keenly for the packets. They also seized empty packets, but they did not remain long about them. Other experiments proved that the fish uses its olfactory apparatus as an organ with which to scent its food; *i.e.*, "its olfactory apparatus is a distance-receptor of very considerable importance in its daily activities."

WEB-SPINNING PSOCHID. Mr. E. Ernest Green calls attention to a Ceylonese Psochid (*Archipsochus*) which produces spider-like webs on trees. While silk-spinning is common among larval insects, "the power of producing silken webs is extremely rare amongst adult winged insects, and appears to be confined to certain species of the lower and more archaic families of the order Neuroptera. The Psochid in question produces silk at all stages of growth. The filament is emitted from near the mouth and is carried back between the legs of the insects. As they wander about they leave a trail of silk behind them and cover whole trees with their web. It looks like a snare, but it is probably protective. The insects usually rest during the day on the bark beneath the web, probably feeding on minute Algae and moulds.

HABITS OF GLOWWORMS.—Mr. Elmhirst, Superintendent of the Biological Station at Millport on the Clyde, has recently made some interesting observations on glowworms (*Lampyris noctiluca*), which are often plentiful in a rather marshy field adjoining the Laboratory. The males sometimes appear in great swarms of at least several hundreds. The females often take up and occupy a permanent position, night after night, until they mate. Male glowworms, like most insects, show a marked preference for red light, which is curious in this particular case, since the light of the female, which should be specially attractive, is at the other end of the spectrum. Mr. Elmhirst also remarks that the light of Finsen rays showed by Dr. Malcolm Laurie in the field did not serve to attract the male glowworms. "This experiment ought certainly to be tried again, and should under favourable conditions succeed in attracting the male glowworms, since the spectral analyses of Finsen rays and glowworm light are similar.

MYRMECODIA.—There has been much discussion over the significance of the labyrinthine stem-tubers of *Myrmecodia tuberosa*, a famous Javanese epiphyte. The mazy passages and caverns of the tuber are tenanted by ants (*Iridomyrmex myrmecodiae*) and it seems very difficult to get at the truth concerning the relations between the ants and the plant. Beccari thought that the ants were responsible for the labyrinth, but Forbes and Treub proved that there could be typical labyrinths in the entire absence of ants. It seems certain that the tuber is a water-absorbing and water-storing structure. Miehe has recently pointed out that some of the walls of the cavities are smooth and light brown, while others are warty and dark brown. A dark fungus grows on the rough surfaces, not on the smooth. The ants deposit their excrement on the rough surfaces; they use the smooth-walled chambers as nurseries. It is probable, Miehe thinks, that the excrement of the ants is utilised by the plants. The ants do not seem to eat anything that belongs to the plant, though what they eat is unknown. Nor do we know how far the ants are necessarily bound up with their convenient labyrinthine shelter.

REVIEWS.

BACTERIOLOGY.

Microbiology for Agricultural and Domestic Science Students. Edited by CHARLES E. MARSHALL. 724 pages. 128 illustrations and 1 coloured plate. $8\frac{1}{4}$-in. × $5\frac{1}{4}$-in.

(J. & A. Churchill. Price 10/6 net.)

This is perhaps one of the most comprehensive books on Bacteriology, using the term in its broadest sense, that is at present available to English readers. Its production has been rendered possible as the result of the coöperation of a number of American workers, each of whom is a specialist in the particular branch of the subject on which he writes. It follows that the work covers a wide field, embracing as it does, in addition to ordinary bacteriological methods and technique, such branches as the microbiology of water, sewage and soil, milk, plants and special industries. The culture, morphology and physiology of micro-organisms is fully dealt with, and in a manner that appeals particularly to those who are called on to apply bacteriological methods to commercial or industrial processes.

Some apology is offered in the introduction for what is evidently regarded as a somewhat serious objection to a work which is the product of several hands, that there may be some inevitable repetition.

It must be admitted, however, that this fault, if it exists, is not at all conspicuous, a tribute, it may be, to the care exercised by the editor. The book may be recommended to those who wish to acquire a sound knowledge of the subject. It is none the less valuable because it deals not only with laboratory methods, such as may be found in nearly all works on bacteriology, but is devoted especially to practical applications.

J. E. B.

BOTANY.

Types of British Vegetation.—Edited by A. G. TANSLEY, M.A., F.L.S. 416 pages. 36 plates and 21 text-figures. $7\frac{1}{2}$-in. × 5-in.

(The Cambridge University Press. Price 6/- net.)

Plant Ecology is one of the most interesting branches of Botany, and is also one of the youngest, its emergence as a definite department of the study of plant-life being of quite recent date. Ecology is more or less closely related to plant-geography on one hand, and to plant-physiology on the other. The study of plant geography in the wide sense goes back at least as far as Humboldt's time, and is concerned with the compilation of a list ("flora") of the species growing in larger or smaller areas and with the division of the earth's surface into "floristic" areas according to the number of species, genera, and families common to them. In a broad sense, the object of physiology is the study of the external factors of the environment in which the plant lives, and of the activities and structural adaptations of the plant itself—the former are the causes, and the latter the effects of these causes. However, the scope and objects of Ecology are distinct enough from those of floristic plant-geography as well as from those of plant-physiology, and it may be defined as the detailed and systematic study of plant-communities, in their relations to each other. A plant community is simply a grouping of certain kinds of plants which are always found associated together under definite conditions of life, or—to quote from the introduction to the book under review—it is "a vegetation unit regarded as an aggregation of species and individuals instead of as a division of the whole vegetation of the region."

This book, which contains numerous photographic illustrations, well selected and admirably reproduced, in addition to useful maps and diagrams, is the work of several authors, but so skilfully has the difficult task of the editor (also himself largely a contributor) been done that the work presents all the obvious advantages of this plan without any of the drawbacks that it might have involved. The result is a work which not only marks an epoch in the study of vegetation, but is also absolutely indispensable to all students of the British flora who wish their studies to extend beyond the mere collecting and naming of plants. The book will prove of the greatest value to the increasing number of field-botanists in this country, to lovers of Nature, to students of scientific geography, and to everyone interested in plant-life. It should certainly be on the shelves of every school in which Nature-study is taught, and should become an essential companion to the "flora," field note-book and pocket-lens on botanical excursions—fortunately, the form of the book is well adapted for pocket use, though an india-paper edition would be welcome when the book comes into general field use, as it undoubtedly will.

Following the editor's concise and clear introduction on the units of vegetation and their relationships and classification, the work falls into two parts. The first part (forty-seven pages) deals with the physical characters, climate, and soils of the British Isles, and is mainly the work of the editor, though Dr. W. G. Smith contributes the section on Scottish soils, and Professor Grenville A. J. Cole that on Irish soils. This part of the book serves as a necessary preliminary to the detailed study of the vegetation, and also forms in itself an admirably terse, fresh, and interesting presentation of these physiographical subjects, and as such is well worth careful perusal by students and teachers of Geography.

The second part, comprising the remainder of the book (over three hundred and sixty pages), presents in detail the existing vegetation of the British Isles, and is prefaced by the editor's general account (Chapter I) of the distribution of the vegetation. This is followed by fourteen chapters dealing with the plant formation of clays and loams, the vegetation of the coarser sands and sandstones, the heath formation, the plant formation of the older siliceous soils, the vegetation of calcareous soils, aquatic vegetation, the marsh formation, the vegetation of peat and peaty soils, the vegetation of the river valleys of East Norfolk, the moor formation (lowland moors, upland moors of the Pennine Chain), arctic-alpine vegetation, and the vegetation of the sea coast. In these chapters the editor has had the collaboration of various botanists, who have made special studies of certain areas, the chief contributors being Miss Pallis, Dr. Smith, Dr. Moss, Professor Oliver, Dr. Lewis, and Dr. W. M. Rankin. Throughout this second part of the book one realises that the editor has, in addition to his own contributions, performed with entire success the difficult task of arranging and co-ordinating the various sections including material from very many sources.

As an example of the way in which the plant formations are dealt with in this work, we may select one of the most familiar, yet one of the most interesting of all—the heath formation. The heathlands of Britain, and of north-west Europe as a whole, are typically developed on poor sandy and gravelly soils, where the climate is wetter than that which, to the extreme east of Europe, gives rise to steppe; on the other hand, moorland is developed in regions of high rainfall, but also on the sites of old lakes or where surface-water poor in mineral salts has accumulated. The typical heath areas are treeless, and the dominant plants are the dwarf shrubby members of the "heather" family; the ling (*Calluna vulgaris*) is by far the most widespread and abundant species, and with it are associated bell-heath (*Erica cinerea*) and bilberry, and (in damp places) cross-leaved heath (*Erica tetralix*): these four Ericaceous species are the most abundant, but many characteristic plants are associated with them. In constantly wet places—for instance, where owing to local hollows the ground-water reaches the surface and a bog is formed—peat may accumulate to a greater depth than on the dry heaths, and owing to its acid character there occur many species of the moorland formation, though in very different proportions.

In this book, however, the various formations are not treated merely as isolated elements in the vegetation; the relations of the different formations to each other are indicated, and the processes by which one formation passes over into another are fully illustrated, with references to localities where such changes may be clearly traced. Heath-land has in some cases arisen *de novo* on the poorer sands, as can be seen in various areas where lichens and mosses form a layer of peat and act as pioneers for the typical heathland vegetation. In many cases, however, it is certain that the heath formation has arisen as the result of the degeneration of woodland; this process may either have taken place in prehistoric times, or may be actually going on at the present day. The heath formation is in many districts constantly and successfully invading and eventually replacing the natural woodland of sandy soils. The main cause appears to be the gradual impoverishment of the soil by washing-out when the rainfall is twenty-eight inches or more; the typical plants of the wood-"floor" are starved and give way before the invasion of heath-plants; the roots of these invaders mat together the surface soil layers and prevent the access of oxygen, and this leads to the accumulation of "acid humus" or "dry peat" in place of the original mild humus of the woodland soil. Thus we have the formation of a type of wood with a heathy vegetation, poor in species, on a soil composed of sand and dry acid humus or peat; and finally the roots of trees are either prevented from obtaining sufficient food owing to the continued washing-out of the soil, or are prevented from growing deeply enough owing to the formation of a hard layer of sand ("moor-pan") bound together by humous compounds, and the trees themselves die out, so that the woodland is replaced by heath. On the other hand, in some areas the heaths are being colonised by self-sown pine-seedlings, so that here we have a process of natural afforestation of treeless heathland.

Fine areas of heathland, where these processes, as well as the actual heath vegetation, may be well studied, occur in various parts of the country, and—as in the case of the other formations described in the book—readers will find detailed references to localities for such studies in whatever part of the British Isles they may be residents or visitors. For instance, around London and within easy reach on the "Surrey side" we find fine heath formations, with illustrations of the degeneration of woodland, encroachment of heath vegetation, the oak-birch heath association, sub-spontaneous pine-woods, and so on; special mention may be made of the heaths developed on the Lower Greensand, Bagshot sand, and the overlying plateau gravels, at various points between Dorking and Leith Hill on the east and Oxshott and Weybridge on the west.

However, it is unnecessary to indicate further the nature of the contents of this book, which should be obtained by everyone interested in plant-life. The names of the editor and his collaborators are sufficient guarantee for the quality of this "account of British vegetation from a standpoint which has not hitherto been adopted in any general treatment of the plant-life of this country," for they are one and all botanists who have laid the foundations of Plant Ecology in this country, and the most important results of their labours in this field are incorporated in the book before us.

In addition to a list of recent papers on British vegetation, the book is provided with a full index of plant names and also an admirable general index. The low price of the book should help in securing for it a wide sale. The publishers are to be congratulated on their enterprise in producing so reasonably such a well got-up and splendidly-illustrated work, which would not have been dear at a considerably higher price.

F. C.

Studies in Seeds and Fruits. By H. B. Guppy, M.B. 528 pages. 9-in. × 6-in.

(Williams & Norgate. Price 15/- net.)

The author of this book presents an enormous amount of information relating to the absorption and loss of water by seeds and fruits. In fact, one's first impression is that the book is somewhat overloaded with columns of figures and names of plants used in the author's simple weighing experiments, and one cannot help thinking that much better, if less copious, results would have been obtained had the author used a small number of plants and a microscope and a few other methods of research, in addition to "the balance and the oven, aided by a sharp knife and a pocket lens." There is no doubt, however, that the author has made a most extensive contribution of facts to a subject which has been but little investigated, and has also suggested various lines along which further research is desirable. Moreover, packed though this book is with facts and figures, it is extremely interesting and readable on account of the author's interpretation of the facts and the speculations which he bases upon them, and the reader who wishes to "skip" some of the heavier parts of the book will welcome the author's considerateness in providing a concise summary at the end of each chapter.

Probably many readers will regard the twentieth and last chapter as the most interesting in the whole book, dealing as it does with "the cosmic adaptation of the seed." The main theme of this chapter is that the seed offers a clue to the conditions of life in other worlds, as contrasted with the full grown plant which is adapted for terrestrial life only; the former points in the direction of the minimum of life's possibilities, the latter toward the freest conditions for growth. We have said that this book is packed with details, but the details are all too much of one kind; they practically all deal with simple observations on the changes in water content of seeds and fruits during ripening. The aspects of the subject to which the author has devoted his attention are those most easily observed, and while interesting in their way, they certainly do not throw much light on the topics which the author attempts to handle in his speculations regarding the "cosmical" features of seeds. It is notoriously unsafe to build up elaborate theories on a too limited basis of fact, and the author of this work has evidently lost sight altogether of the *chemical* side of the subject. The condition of the dormant dry seed is to a large extent a matter for chemical investigation. There are only two alternatives with regard to the latent vitality of seeds—either vital processes (involving chemical changes) are still going on continually through slowly, or else all change is at a standstill. Which of these alternatives is correct has not yet been determined, and apparently can only be determined by keeping dry seeds in a vacuum and testing them at intervals during a long period, as it is proposed to do with the seeds deposited by Becquerel at the Bureau of Standards in Paris. Meanwhile, however, various chemical and physiological facts make it extremely improbable that even the protoplasm of any dry resting seeds can retain its vitality for much longer than did the veteran seeds tested by Becquerel, and found to germinate after eighty-seven years of repose in a herbarium. In the respiration of certain plants, no oxygen is taken from outside, while in the case of succulent plants respiration occurs without any carbon dioxide being given out, and—as suggested by Dr. F. F. Blackman (*New Phytologist*, vol. 8, p. 35)—it is quite possible that in the latent protoplasm a steady though small supply of energy might be set free, without any change being caused in the surrounding medium. Such a process would of course end, after a number—probably a comparatively short number—of years, in death of the protoplasm. Again, it has of course been proved that dry dormant seeds, spores of Bacteria, and so on, can endure extreme cold, but it does not follow that no chemical changes can take place in the protoplasm of cells exposed to the lowest temperatures.

The seed is an organ of the greatest interest from many points of view—morphological, physiological, phylogenetic, physiological and ecological. New work on the seed from every side cannot fail to be of service in contributing to the store of knowledge concerning the evolution, structure, and physiology of the most complex organ in the vegetable kingdom. For this reason botanists will welcome Mr. Guppy's book, which shows how much can be done in plant physiology by the use of the simplest possible methods of experimentation.

I. C.

GEOLOGY.

Earth Features and their Meaning. By W. H. HOBBS. 506 pages. 24 plates. 493 illustrations. 9 in. × 6 in.

(Macmillan & Co. Price 12/6 net.)

This book gives in expanded form the substance of a series of lectures delivered at the University of Michigan. We may say at once that if the lectures were delivered as interestingly as they are written, the students had a most instructive and fascinating experience. The book deals with geological principles elucidated from the character of the different earth features as these are found in their respective environments. The book not only caters for students but also for tourists and travellers, and is intended to help them to have a keener and more seeing eye for the landscapes through which they are constantly passing. Stress is continually laid on the character-profiles of the land as due to various agents such as wind, ice, and running water, so that he who runs about the earth may read with greater ease the more significant lines in the moving landscape, and add notably to the pleasure of his journeying. To further this aim, most of the examples and illustrations have been drawn from well-known tourist routes, and suggestions concerning the itinerary of geological journeys are supplied in a long appendix.

This is a textbook with a decidedly original outlook. It differs from most others in not attempting to combine in a single text historical with dynamical and structural geology. The author applauds the tendency, rightly as we think, to treat historical geology especially as a subject in itself. The inclusion of all branches of geological science in a single textbook renders it unnecessarily encyclopaedic and repels the general reader. The book is written in an easy, pleasant style, devoid of formality, the only blemish of which is an inordinate use of the split infinitive. It is extremely valuable to students in that it presents in a popular form the latest results of research in dynamical geology; for which we are mainly indebted to American geologists. Written by an American and with most of the examples and illustrations of American origin, the book is pervaded by the wide continental atmosphere which is so needful as a corrective for the insular experience of most European geologists. As a typical example of the wider view we note that the parallel roads of Glen Roy are used merely as introductory to a fascinating account of the enormously greater glacial lakes of North America, which were the precursors of the present great lakes of the St. Lawrence basin. Glaciers and their work, past and present, occupy a little less than half the work, on the ground that glaciers have shaped most of the prominent earth features near the colleges and universities in northern America and Europe.

The book is illustrated by twenty-four plates and nearly five hundred line drawings, many of which are extremely good. It is difficult, however, to make anything of a few of the drawings, notably Figures 110 and 209, which are too slight to be at all informative. There are appendices dealing respectively with the quick determination of the common minerals and the short descriptions of the common rocks, but it is difficult to see their use in a textbook of this kind. Moreover, they are inconsistent with the author's expressed views that geological textbooks are overloaded by attempting to deal with all aspects of the subject. Further appendices on the preparation of topographical maps and laboratory models for study in the interpretation of geological maps, describing some ingenious apparatus for this work, stand in a different category. To each chapter of the book a brief but valuable and up-to-date set of reading references is appended.

G. W. T.

The Student's Handbook of Stratigraphical Geology. 2nd Ed. By A. J. JUKES-BROWNE, B.A., F.R.S. 668 pages. 219 illustrations. 8 in. × 5½ in.

(Edward Stanford. Price 12/- net.)

Stratigraphy, even if confined to Britain alone, is now far too large a subject to be dealt with satisfactorily in the encyclopaedic textbook of geology. Hence one notes with approval the appearance of this work as indicative of the recent tendency to treat stratigraphy as a subject in itself, worthy of exhaustive and specialised treatment. The author, than whom no one is more qualified to write on British stratigraphy, has revised and partly re-written the account of the British strata appearing in the first edition; and, moreover, has added more complete accounts of the continental representatives of the various formations. While the British Isles contain a fairly complete epitome of the geological column, some parts of it are missing and others shew abnormal facies. Hence the wider view afforded by a concurrent study of the corresponding European strata is a valuable corrective for the insular notions the student is apt to get whose knowledge is confined to the British rocks alone. Mr. Jukes-Browne infuses life into his dry facts by giving a short account of the conditions of deposition and physical geography of each period, a subject he has dealt with, of course in much greater detail, in his "Building of the British Isles." The description of each system is prefaced by sections on the nomenclature and classification of the strata and on the life of each period, which is illustrated by numerous figures of fossils. At the beginning of the book are three valuable chapters on the often-neglected general principles of stratigraphy, stratigraphical palaeontology, and the literature of historical geology. The latter chapter gives a concise list of the more important works on British stratigraphy. This is supplemented by detailed reference to original work at the end of each chapter.

The author thinks there is no reason why the terms Primary, Secondary, and Tertiary should not be employed as timewords instead of the more cumbrous Palaeozoic, Mesozoic and Cainozoic, which are based on palaeontological facts. The latter terms, however, are so firmly established that we do not think the suggestion will meet the approval of the majority of geologists. On the other hand, Mr. Jukes-Browne would like to abolish another old-established term—none other than the Old Red Sandstone, which he stigmatises as a particularly awkward and unsatisfactory name. We are glad to note a good account of recent work in the Highlands of Scotland, an area with which it seems stratigraphers need to be courageous.

The book is well illustrated with maps and sections, and has an excellent index. It will be indispensable to all students of British geology as the fullest and most up-to-date account of our stratigraphy.

G. W. T.

HEREDITY.

Heredity—("The People's Books": No. 10).—By J. A. S. WATSON, B.Sc., F.R.S.E. 94 pages. 11 illustrations. 6½-in. × 4½-in.

(T. C. & E. C. Jack. Price 6d. net.)

In this book Mr. Watson has made a heroic attempt to condense into ninety very small pages a sketch of the various lines of approach to the solution of problems of heredity. That he has been able to explain so much with such remarkable lucidity in so small a space is nothing short of marvellous; yet one lays down the book with the feeling that the author has been obsessed throughout by the problem that besets the concocter of telegrams, to convey the maximum of information in the minimum of words. The chapters on Mendelism, in particular, are somewhat overcrowded, and parts of them might well puzzle a reader having no previous knowledge of the subject; but it would be impossible to deal more clearly with so wide a range of instances without demanding more space.

The best of the many good points of this carefully-written and well-reasoned book is that it emphasises more strongly than any similar book within our knowledge the agreement, overlapping and mutual interdependence of the statistical and Mendelian methods of investigation. Controversial subjects are treated with scrupulous impartiality, evidence being as rigorously railed off from opinion as stalls are from the pit. In fact, the book has only one fault: it is too short.

W. Hope-Jones.

MATHEMATICS.

Tables Annuelles Internationales de Constantes et Données Numériques, Vol. I. 727 pages. 11-in. × 8¾-in.

(J. & A. Churchill. Price 21/6 paper, and 24/- bound in cloth.)

This, the first fruits of the labours of the International Committee appointed by the Congress of Applied Chemistry in 1909, is a huge volume representing a vast amount of patient labour. The work is published under the patronage of the International Association of Academies, and material as well as moral help has been given by various Governments and Scientific Societies. A long list of these appears on one page. It is interesting to note that the Governments of Austria, France, Holland, Russia and Switzerland are included. The British Government and the Royal Society are conspicuously absent. The Royal Dublin Society and the Royal Irish Academy, and the Royal Societies of Canada and Edinburgh figure among the British Societies, an argument, perhaps, for Home Rule all round. To criticize a work of this kind in a review is impossible. The proof of the pudding is in the eating, and the size and varied ingredients of this particular pudding should make it a standing dish in all chemical and physical laboratories.

W. D. E.

METEOROLOGY.

Forecasting Weather.—By W. N. Shaw, F.R.S., Sc.D. 380 pages. 158 illustrations. 8¾-in. × 6-in.

(Constable & Co. Price 12/6.)

Everyone is interested in the weather, for everyone is affected by it, but while the state of the weather is a matter of concern, a question of even greater importance is, What will the weather be? Most people are "weather wise" to some extent, but in this book we have the latest and most authoritative views on the subject of weather forecasting, from the standpoint of the professed meteorologist, who is at the same time a master in physical science.

Dr. Shaw has been for the past eleven years the head of the Meteorological Office in London, but before that he was for twenty years engaged in teaching physical science in Cambridge, and he has brought to the preparation of this book the experience gained from the continuous study of weather forecasting in the light of experimental physics.

The result is a valuable volume in which the modern practice is fully detailed, and at the same time the theory on which the practice is based, and the relations that exist between the phenomena of the weather and the facts of physical science, are set out and explained.

Modern forecasting is based upon the knowledge of present conditions over a more or less wide area, and in practice these present conditions are represented by means of synoptic maps. The author, therefore, devotes his first chapters to the history, method of construction and gradual development of synoptic weather maps, and to a study of the relationships that exist between barometric pressure and wind, temperature and weather, and gives a clear exposition both of the information the daily weather map gives and of the inferences that may be drawn from it.

Some branches of science demand for their successful prosecution an expensive instrumental outfit, but this is not the case with weather forecasting, and it is shown that a barometer and thermometer are all the instruments necessary to enable one to make effective use of the weather maps issued day by day.

It has often been objected that the Official Forecasts are not sufficiently precise to be of service, and in connection with this criticism Dr. Shaw devotes a chapter to local variations of weather in relation to certain definite weather types. Some most interesting diagrams are given, showing how under the same conditions local phenomena—rainfall, for instance—will differ at different stations in the same district, and how important local knowledge is in interpreting the maps and forecasts.

While everyone is interested in weather forecasts there are certain classes of the community who are very specially concerned. Amongst these are seamen, agriculturists, aeronauts and colliery managers, to whom the knowledge of the weather conditions of a few hours ahead is sometimes all important. In America, very special attention is given in the interest of fruit growers, to the issue of warnings of cold waves, and in our own islands the accurate prediction of night frosts, or of the probable weather in harvest, is of great importance. Dr. Shaw devotes special chapters to each of the classes mentioned, pointing out the varying needs of each, and the special difficulties the forecaster has to overcome in order to render his predictions really serviceable.

For a successful forecast it is necessary to take a wide survey, and for a wide survey it is necessary to use observations made outside the British Isles. A very real difficulty experienced by workers in Meteorology, when dealing with results obtained in different countries, is the want of uniformity in the units employed. Dr. Shaw boldly meets this difficulty by advocating a uniform system of C.G.S. Meteorological Units, the general use of which would clearly be an immense boon. It is hardly likely that the new system will be brought into general use at once, but it is a notable step forward to have developed a practical scheme and to have indicated the line of advance.

The book is well got up and is very fully illustrated with an admirable selection of charts and diagrams. Many of these are, however, on a small scale and need a lens for their proper study.

The author is to be congratulated upon the production of what probably will be the standard work on weather forecasting for many years to come.

PHYSICS.

The Energy System of Matter: A Deduction from Terrestrial Energy Phenomena.—By James Weir. 200 pages. 12 diagrams. 8-in. × 5¼-in.

(Longmans, Green & Co. Price 6/- net.)

The author of this book considers that modern science is too metaphysical. In particular, he is opposed to the hypothesis of the ether of space. He argues that it is absolutely impossible to explain phenomena, that all that can be done is to describe them. After this, he proceeds to attempt an explanation of all natural phenomena in terms of matter and energy, both of which, as presented in his book, are metaphysical entities. He is, therefore, hardly consistent.

His main thesis is that "Every transformation of energy is carried out by the action of energised matter in the lines or field of an incepting energy influence." As an example of what he means by an incepting energy influence, gravity may be instanced. He argues that the planetary bodies are absolutely separated from one another, and from the sun, and that no energy is transferred from one to another. Across the empty space between them, however, gravity is operative as a passive influence. According to the author's theory, all the various forms of energy manifested on a planet are derived from the energy of its axial rotation, under the incepting influence of gravity and other similar fields (e.g., thermal, luminous, and so on), and all such energy is ultimately transformed back into axial energy by means of the atmosphere. Each planet, therefore, is an absolutely conservative system.

Mr. Weir denies, of course, the existence of radiant heat, and argues that since there is, in his opinion, no transmission of energy from one celestial body to another, there is no necessity to postulate the existence of a medium filling the spaces between. But surely, even admitting the truth of his theory of incepting energy influences, if it is necessary to assume the existence of "matter" to support those phenomena which are loosely spoken of as "properties of matter," surely it is not necessary to assume the existence of "ether" to support or constitute the "lines or field of the incepting energy influence." It is true, we think, that science is not concerned with the ultimate explanation of phenomena; that is the business of metaphysics. But Mr. Weir ought not to be metaphysical and antimetaphysical in one and the same breath.

The author's arguments seem very far from conclusive as to the supposed return of all terrestial energy to the form of axial energy; and what he terms experimental evidence not infrequently turns out to be merely discussions of purely hypothetical machines which cannot be constructed. Moreover, his discussion is limited to only the simplest phenomena—electrical phenomena are barely touched upon, for example. It is, further, hard to see how Mr. Weir's views can be reconciled with the phenomenon of the increase of mass of a charged particle when its velocity approaches that of light, since Mr. Weir assumes as absolutely true, the law of the conservation of inertia, which, using an inaccurate expression (now generally discarded), he calls the law of the conservation of matter.

We by no means say that Mr. Weir's book is lacking in interest, but we certainly doubt whether modern physical theories concerning matter, energy and the ether will be seriously affected by its arguments.

H. S. REDGROVE.

An Experimental Course of Physical Chemistry. Part II. Dynamical Experiments. By T. F. SPENCER, D.Sc., Ph.D. 256 pages. 68 illustrations. 7½-in. × 5-in.

(G. Bell & Sons. Price 3/6 net.)

This book forms the second part of Dr. Spencer's book which has already been reviewed in "KNOWLEDGE." It is an even more valuable contribution to the library of the practical worker in physical chemistry. The experiments in the chapter on Mass Action will give the student clear ideas on the subject of Chemical Dynamics; the chapter on Conductivity of Electrolytes is thoroughly practical and useful. The chapter on Dielectric Constants will be useful to the advanced worker, but might have been rather more fully dealt with, the descriptions being rather sketchy. The chapters on Transition Temperatures and Radioactivity are also most useful in a small handbook of this sort. Other chapters on Transport Numbers, Electromotive Force, and Thermo-Chemistry are included. The book is bound to be much used by students and those workers who desire to make occasional physico-chemical measurements.

A. C. G. E.

A. B. C. of Hydro-dynamics. By Lieut.-Col. R. DE VILLAMIL, R.E. 135 pages. 48 illustrations. 8¾-in. × 5½-in.

(E. & F. N. Spon. Price 6/- net.)

This book is somewhat of a controversial character, and full of quotations, criticisms and contentions. For this reason, alone, the book must be an interesting volume; but it is written also by one who possesses a grasp of the subject and an original insight into such matters as it deals with. It is a book that requires reviewing very thoroughly, if it is reviewed at all, and the writer prefers to bring it to the notice of readers of "KNOWLEDGE" without a long discussion on Hydro-dynamics, leaving it to them to form their opinion on the book. The scope of the book ranges through the following subjects: the resistance of liquids, viscosity, "stream-lines," Stokes' law, vortices and the sensitive flame.

A. C. G. E.

Tables of Logarithms, Anti-logarithms and Reciprocals. 6 pages. 9½-in. × 6 in.

(C. & E. Layton. Price 1/-.)

These are a clear set of well-printed logarithmic tables of four figures, easy to manipulate and useful for laboratory and statistical purposes.

A. C. G. E.

Studies in Terrestrial Magnetism.—By C. CHREE, M.A., F.R.S. 206 pages. 43 illustrations. 9-in. × 6-in.

(Macmillan & Co. Price 5/- net.)

The above book is one of a series of monographs, published by Macmillan & Co., which are intended to give the results of the work of their authors in a connected form, and should prove most valuable. Professor Chree is the first authority on all matters connected with terrestrial magnetism, and the book sets out the result of his long series of researches. As he states, the book deals almost entirely with facts and the absence of any definite theory as to the origin of magnetic changes is due to no lack of curiosity as to the causes of things. The phenomena of terrestrial magnetism are of a complicated nature and the book will surely be of great interest to all those who take an interest in physical matters; for they will be shown how Professor Chree has steered his way through a very intricate field of inquiry and collected much valuable information of natural processes. Physicists will be most interested by the chapters which deal with magnetic storms, and the connection between the earth's magnetism and sunspot activity.

A. C. G. E.

NOTICES.

EDWARD SMITH.—Mr. Edward Smith, whose name was mentioned in the July number of "KNOWLEDGE," page 279, as the author of "The Life of Sir Joseph Banks," was in two places accidently referred to under the Christian name of George; a mistake which we hasten to rectify.

THE BACTERIOLOGY OF LEPROSY.—Our reviewer, in dealing with the Fourth Report of the Wellcome Research Laboratories, said that no reference had been made in it to the work of Beauchamp Williams on the Bacteriology of Leprosy. Dr. Andrew Balfour, Director of the Laboratories, writes to say that a resumé of the work in question was given on pages 166 and 167, under the heading of "Additional Notes." Dr. Balfour adds the interesting information that it is hoped at the Wellcome Research Laboratories to proceed on similar lines in preparing a vaccine for the common and crippling disease known as Mycetoma or Madura Foot. Captain Archibald, who has succeeded in cultivating the parasites from several species, has, in fact, put himself into communication with Dr. Williams on the subject.

DALLMEYER CAMERAS.—We have received a brief list of Messrs. Dallmeyer's Cameras, amongst which we notice the Carfac collapsing cameras which extend in a very simple manner, can be loaded in daylight with films, and are British made at Messrs. Dallmeyer's factory at Willesden. There is also included a special correspondent's camera which was designed for newspaper men during the South African war, and which has since been improved, as well as roll film cameras, a reflex for naturalists, and double extension stand cameras.

SCIENTIFIC BOOKS.—We would bring to the notice of our readers Messrs. Henry Sotheran & Company's catalogue, numbered 725, containing a list of more than two thousand books on mathematics, chemistry, physics and astronomy, and also their catalogue numbered 728, which contains a number of scientific books.

THE ISLE OF WIGHT BEE DISEASE.—The Board of Agriculture issued with the May number of its *Journal* a supplement consisting of over one hundred and forty pages dealing with the investigations which have been made on the Isle of Wight Bee Disease in the Pathological Laboratory, Cambridge. The infection may be transmitted through the agency of infected food or a living bee. Sometimes the stock remains healthy and the infected bees are gradually eliminated. Frequently, however, the stock suffers severely or from a mild form of the disease and succumbs. Various conditions tend to lessen the natural resistance of the bee and no permanent cure has apparently been recorded.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

SEPTEMBER, 1912.

LIFE WITHOUT MICROBES.

By F. P. MANN.

SEEING that microbes are always found to accompany the different manifestations of life, it was, in fact, supposed that they were even a necessary condition for the existence of human beings and animals of different degrees. Scientific men have hitherto been of the opinion that life, without microbes would be impossible, at least, for the higher animals, even though recent researches showed that some insects could live when free from such germs. It was very difficult to throw any light upon this very important

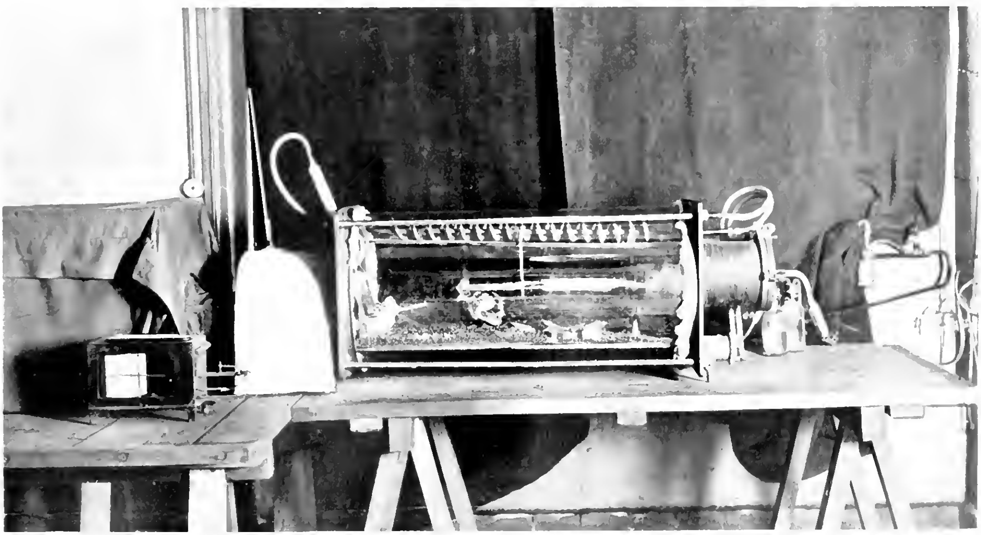


FIGURE 357. M. Michel Cohendy's Apparatus.

point, as what was needed was to be able to raise an animal and allow it to grow under conditions in which no microbes could reach it. M. Michel Cohendy, of the Pasteur Institute of Paris, undertook to solve the problem by raising live chickens in an enclosed space which was quite free from microbes. By the use of an ingenious apparatus for hatching the chickens and then raising them for a certain time, he was able to produce animals which did not contain any microbes in their bodies, and they were able to live and appeared to be as healthy as usual. M. Cohendy very kindly furnished us with the present description of his method.

What is needed in the present case is to have a suitable means for raising the chickens, starting with the egg, and then to allow them to grow under good conditions for several weeks, all the while being quite free from microbes. M. Cohendy was obliged to take great care in designing an apparatus which would carry out this purpose, seeing that it is quite easy for it to be contaminated with microbes which are always floating in the air or are contained in the different substances needed within the apparatus. He operated, in the first place, in a special antiseptic room which has the walls and floor well sterilized so as to reduce the number of microbes in the air to a very small amount to begin with. Then he made the apparatus which is represented in Figure 357, and it serves in the first place as an incubator for hatching the eggs and then as a chamber where the chickens are able to live as long as may be desired. The main glass cylinder with an inside sheet metal floor serves for the live chickens, and opening into it on the left hand side is a smaller metal chamber used as the incubator. A felt curtain hangs over the opening between these two chambers. The incubator part is kept covered over with a piece of heat-protecting felt. A round metal door in the incubator end allows of putting in the eggs, and there is a second door in the metal chamber lying at the other end of the cylinder for taking out the live chickens or for putting in grain, sand, and all that is needed here.

The incubator is kept as usual at the right heat for hatching the eggs, by the use of a small outside gas burner placed underneath. But after the chickens are hatched, it is required to use a lower temperature in the glass cylinder in which they are to live, so as to keep it at about the same heat as under ordinary conditions. One precaution to be taken is to keep the heat of the chamber at a somewhat lower point than what prevails in the room, as M. Cohendy found that unless this were done, the vapour within the cylinder will condense and form dew upon the inside, and this runs down and keeps the floor and the sand always wet. This he now avoids by using a worm tube which will be noticed running along the top and inside the cylinder. It has cold water from the main circulating in it, and this water is sterilized along its course before entering the chamber, as an extra precaution. It is also required to supply drinking water to the chickens, and this is done by using a small plate or trough running along under the worm tube. A slight amount of water is always condensed from the chamber upon the cold tube, and this runs down the trough to one end of the chamber where it collects in a small drinking vessel. The grain and sand are well sterilized before putting them into the apparatus so that they are quite free from microbes, as is found by suitable tests in the first place.

Before putting in the eggs, the apparatus as a whole is taken to a sterilizing apparatus, and is put into it and kept at a heat somewhat above the boiling point of water, so as to destroy all the microbes. The two doors of the cylinder are made with rubber joints with an extra protection of cotton which prevents microbes from entering. The air also needs to be kept renewed inside the apparatus while the chickens are living, and this is done by using a tube which runs through the laboratory window to the outer air. An air circulation is kept up in the apparatus, using sterilizers in the path of the tubes, so that the incoming air is quite pure. An ingenious method consists in keeping the air pressure inside the apparatus somewhat higher than what prevails outside, so that when it is required to open one of the doors there is a slight outrush of air from the cylinder so as to drive out any microbes which would tend to enter with the air. It is recognised that eggs when in a healthy state do not contain any microbes in the inside. The outside of the egg is well cleaned and sterilised, then three or four eggs are put into the incubator. This requires the utmost care in order to keep any germ-laden air from entering at the same time, and the author makes use of a rubber cloth-covered box which is quite similar to a photographic plate charging box, with holes for the arms. The inside of the box is carefully sterilized, so that this allows of taking the eggs in the hands and by means of the box they are placed within the incubator. The protecting box will be noticed to the left of the apparatus. During the raising, a set of open bouillon tubes within the cylinder showed whether there were any microbes inside.

M. Cohendy thus succeeded in raising chickens for forty-five days which were found by analysis of the contents of the digestive organs, blood and various parts, to be free from microbes. A longer time could not be given, owing to the size of the chamber which was very difficult to make even of the present proportions. A number of check specimens were raised in the same way but the usual microbes were allowed to enter. The author's specimens seemed nevertheless to be as healthy as the others, and when taken out into the air their bodies became peopled with disease and other microbes in about twenty-four hours; but, as might have been expected, they did not suffer at all from this, and the change over did not appear to affect them, as they grew up to adult size. These experiments seem to show that the preparation of the animal organism for fighting disease microbes is not the result of individual acquisition, but is hereditary, and the conclusion is that life without microbes is possible for the higher animals, without any bad effect on the organism. It can no longer be said that microbes are a necessary condition for living animals.

ON STELLAR AND NEBULAR DISTANCES.

By PROFESSOR FRANK W. VERY.

Westwood Astrophysical Observatory, Westwood, Massachusetts, U.S.A.

At the meeting of the British Astronomical Association, Wednesday, November 29th, 1911, my paper—"Are the White Nebulae Galaxies?"* was introduced for discussion by Mr. Lynn. In the remarks which followed, some favourable, others adverse, Dr. Crommelin said that "sensible proper motions did not show any perceptible increase in the direction of the Milky Way," and that this was fatal to the distance which I have assigned to the Galaxy. He also cited Newcomb's distance as being fifty times mine.

It is quite true that there are no evidences of a marked increase of proper motion among the galactic stars; but since, in my view, the galactic velocities are small, because they have been annulled to a great extent by internal collisions among the component parts out of which the central condensation has developed (and this is why there is such a great accumulation of material in this region), it follows that sensible proper motions are not to be anticipated among the galactic stars. A velocity of one astronomical unit ($1 \cdot 5 \times 10^8$ kilometres per annum) would give to a galactic star at six hundred billion kilometres (6×10^{14} kilometres) a proper motion of $\frac{200,000 \times 150,000,000}{600,000,000,000,000} = 0'' \cdot 05$ per annum. This gives a preliminary conception of the order of magnitude to be expected.

The size which I assumed, namely, $1 \cdot 2 \times (10)^{15}$ kilometres for "the diameter of the galactic spiral in its more condensed discoidal dimension,"* was not intended to include "a wider encompassing shell of sparsely-distributed stars of approximately spherical shape." The latter, reasoning from the analogy of the extreme outer boundary of a star cluster, compared with its condensed nucleus, may be ten times as distant. This gives an outer boundary at a distance $6 \times (10)^{15}$ kilometres from the centre.† Lord Kelvin gave a number five times as large as this for his star-sphere‡, in which, however, he assumed a uniform distribution of the stars, whereas there is undoubtedly a great central condensation and smaller average distance from the centre. It seems to me probable that the real dimensions lie somewhere between these limits.

The immense number of the stars may suggest distances greater than these, but recognizing the great stellar condensation of clusters and galactic streams, the mere numbers, great as they are, do not constitute an insuperable barrier to the supposition that the galactic distances are of the order named.

If the absence of sensible proper motion in many small galactic stars cannot be taken as a sure proof of their great distance, what shall we say of the large proper motions which have been found for considerable numbers of faint stars? Does it not imply that some, at least, of these faint objects are not as far away as the enormous distances which have sometimes been assigned to them? Professor Eastman, classifying a list of five hundred and fifty stars for proper motion, could find no consistent connection between brightness and apparent speed. Twenty-nine stars of the ninth magnitude had an average proper motion three times as great as the average for an equal number of second magnitude stars. Professor Eastman notes that "assumption, which has developed into a quasi-theory and gained general acceptance, asserts that the largest stars are nearest the solar system. Observation plainly shows this theory is untenable."§

If the star-ratio per successive magnitude were purely a space-ratio, it should continue to increase indefinitely for the smaller magnitudes (given sufficient telescopic power). Existing telescopes may not have quite power enough to fix a limit for the galactic stars. Although there is an apparent falling off in the star-ratio beyond the sixteenth magnitude, there may be some doubt whether the photograph registers these very faint stars correctly.

The case is different for extra-galactic regions. Here there is abundant telescopic power, and it is certain that the curve of the star-ratio per magnitude is not a space-ratio, but more nearly resembles the probability curve for distribution of real variation of brightness. This has been recognized, in a way, for some time.

Miss Clerke says: "Somewhere, if the stellar system be—as we have reason to think it is—of finite dimensions, ... distance becoming at length eliminated as a factor of magnitude, the differences of the faintest stars represent, chiefly or solely, real inequalities in shining. There may possibly, for instance, be no 'mean distance'

* *Astronomische Nachrichten*, No. 4536, Bd. 189, November, 1911. *Op. cit.*, column 450.

† Compare F. W. Very, "Stellar Revolutions within the Galaxy," *Am. Journ. of Sci.*, Ser. 4, Vol. XVI, page 132, Aug. 1903.

‡ *Philosophical Mag.* (6), Vol. II, page 161, 1901; also Vol. III, page 1, 1902.

§ *Bulletin Philosophical Society of Washington*, Vol. XI, page 166.

corresponding to the sixteenth magnitude. The stars of that rank would not then, on the whole, be further off than those of the rank next above them, but would, on the whole, possess only [illegible] of their real light."* Yet, in spite of this quasi-recognition of the fallacy of the position that the star-ratio represents a space-ratio, statistical studies of assumed stellar distribution continue with very little regard for this fact.

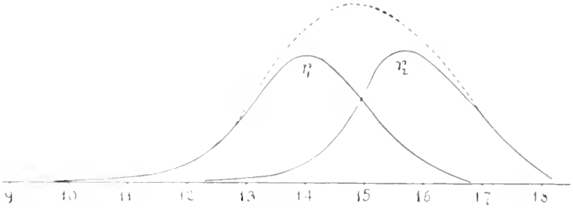


FIGURE 358.

Admitting the extreme condensation of small stars in certain galactic streams, we may possibly reach some approximate estimate of the arrangement and star-density of these streams.

The superposition of distinct galactic rings is strongly suggested by Ritchey's photograph of the Milky Way in Cygnus, near N.G.C. 6960,† where the star density in the right-hand half of the plate suddenly increases to about double that on the left. The following counts are reduced to numbers of stars per square degree:

Left side.		Right side.	
43,600	Mean 35,000	65,200	Mean 78,000
29,500		70,600	
31,300		98,300	

Let us see if these numbers can be represented by a hypothetical distribution of stars, according to some rational conception.

Miss Clerke sums up the consensus of various investigators in the "conclusion that the main part of the annular structure we call the Milky Way lies at a distance from us intermediate between the distances belonging to the tenth and fourteenth stellar magnitudes."‡

If the 10·3-magnitude companion of Sirius,§ which is a body somewhat more massive than the Sun, but giving less than $\frac{1}{100}$ of the Sun's light, were to be transported to the distance which I have assumed for the nearer streams of the Milky Way, or had its parallax diminished from 0"·37 to 0"·05, it would fall below the average brightness of the above definition.

Hitherto, attention has been paid almost exclusively to a few thousand exceptional stars of more than ordinary brightness; but let us now consider rather the millions of insignificant stars—stars which are better represented by the companion of Sirius than by its principal star.

Let us first make the supposition that we are dealing with a spiral structure, equivalent to two concentric rings; the inner, at a distance of sixty light-years, and of such section that its volume is thirty thousand cubic light-years, is supposed to consist chiefly of thirteenth to fourteenth magnitude stars; while the outer ring is at a distance of one hundred and eighty light-years, with both section and distance three times as great, or has a volume of two hundred and seventy thousand cubic light-years, and is composed mainly of stars from the fifteenth to the sixteenth magnitude. These values may be approximately included in a zone 10° wide for the inner ring and 6° wide for the outer ring, or, considering that there is much irregularity in both density, width and grouping, we may take for the width an even ten degrees.

The area covered by the rings constitutes nearly one-eleventh of the entire sky, or nearly three thousand six hundred square degrees, and contains much the larger number of very faint stars; but as far as the ninth magnitude, there is little extra richness. Newcomb found seventy-seven thousand three hundred and seventy stars to the ninth magnitude north of the equator, or about one hundred and fifty thousand stars for the entire sky, of which one hundred and twenty thousand may have been between eighth and ninth magnitude. Our galactic zone includes about one-tenth of these. The star-ratio, × 3·85 per magnitude, has been found for the first nine magnitudes in the galactic part of the sky, and it continues to represent the rate of stellar increase tolerably well as far as the fourteenth

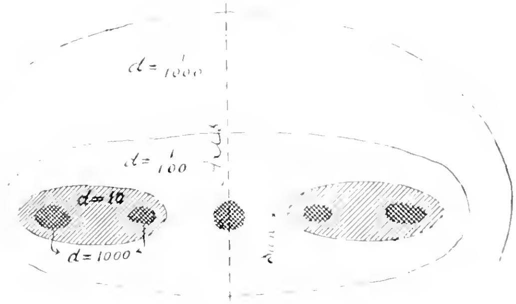


FIGURE 359.

* Miss Agnes M. Clerke, "The System of the Stars," 1st Edition, page 314, 1890.

† G. W. Ritchey, *Yerkes Observatory Publications*, Vol. II, Plate XXVII.

‡ *Op. cit.*, page 366.

§ Magnitude given by E. C. Pickering, *Annals Harvard Observatory*, Vol. XL., page 281.

magnitude in this region, but diminishes rapidly for stars beyond the sixteenth magnitude. This is represented in the following table, where terminal ratios are assumed which express the apparent fact that the star numbers have begun to diminish.

Limits of magnitude	8–9	9–10	10–11	11–12	12–13
Star-ratio	3·85	3·85	3·85	3·85	3·85
Number of included stars	12,000	46,000	177,000	680,000	2,600,000

Limits of magnitude	13–14	14–15	15–16	16–17	17–18
Star ratio	3·85	3	3	·89	·78
Number of included stars	10 Million.	30 Million	90 Million	80 Million	70 Million

The outer ring is three times as far away as the inner by assumption, and if of identical constitution, it should be one-ninth as bright. Since there is approximate equality between the rings, I have made the outer ring nine times as great as the inner. Taking the sums of the included numbers, we have:

Inner ring = 10th to 14th + $\frac{14-15}{2}$ mag. = 13·5M + 15M = 28·5 M.

Outer ring = $\frac{14-15}{2}$ + 16th to 18th mag. = 15M + 240M = 255·M.

Number of stars per cubic light-year:

Inner ring = 28,500,000/30,000 = 950.
Outer ring = 255,000,000/270,000 = 950.

The star density is nearly one thousand per cubic light-year. The total number of stars in the galactic zone, 10° wide, is 255M + 28·5M = 283,500,000, or 79,000 stars per square degree for the combined rings. A direct count on the photograph gave 78,000, which agrees well enough. The distribution of stars (tenth to eighteenth magnitudes) among the magnitudes, may be represented by the sum of two curves, one for each ring, as given in Figure 358. The dotted line gives the star numbers resulting from the compounding of stars in two rings whose separate numbers are represented by the curves, r_1, r_2, whose maxima correspond to about the fourteenth and sixteenth magnitudes respectively.

Admitting that the Sun is situated midway between two galactic condensations in a vacant, yet somewhat central, region, an ideal axial section of the Galaxy, which harmonizes known facts, is given in Figure 359.

The star-ratio per successive magnitude is equal to the ratio of brightness of stars one magnitude apart, raised to the 3/2 power, or to $(2·512)^{3/2}$ = 3·981, provided the distribution is uniform. H. H. Seeliger, from the stars of the Bonn Durchmusterung and of the Southern Durchmusterung to the 9·5 magnitude, found the star-ratio per magnitude = 3·85 for the Milky Way, but only 3·28 for the galactic poles. The variation demonstrates that the stellar distribution in distance, or in brightness, or both together, cannot be uniform: evidently, the limits of the Galaxy have been reached for 9·5-magnitude stars, at least in a direction perpendicular to the plane of the Milky Way. This becomes still more noticeable in a comparison of Pickering's list of stars within 2° of the North Pole with the theoretical star-ratio, from which Ranyard concluded that "instead of over fifteen thousand stars between the fourteenth and fifteenth magnitudes, there are less than four hundred, or only about one four-hundredth part of the calculated number; in other words, about the number of stars which, according to the space-ratio, would lie between the 9·5 and 10·5 magnitudes."* Either we must suppose that there is an absorption of light in space much greater than even that which I have attributed to the distant nebulae, or else the Galaxy is much more restricted than has been supposed. A range of at least ten magnitudes is known to occur in stars whose distances are not dissimilar; hence there is no need of assuming that the excessively faint stars which are massed in the Galaxy must be at distances of thousands of light-years. Neither the faintness of the light, nor the absence of proper motion, is a sufficient reason for rejecting the plain teaching of other modes of investigation.

But in "KNOWLEDGE" for January, 1912,† Dr. Crommelin gives a stronger argument, which we must examine more critically. He says: "It is fairly well established that the Sun moves through some four astronomical units per annum, which, if unforeshortened, would give a star of sixty light-years distance an apparent motion of one-fifth of a second per annum; the galactic stars certainly show no motion approaching this amount, whence it appears certain to me that the Galaxy is far more than sixty light-years distant, so that all Professor Very's estimates of nebular distances would need muliplication by a considerable factor."

In my previous papers I have assumed that our sun is itself a member of the galactic multitude, though remote from the nuclei of condensation, and that an unknown portion of the supposed solar motion is common to the system and may be shared by large numbers of the galactic stars; that is to say, no parallactic motion whatever would be found if the Sun had the average motion of a galactic star, and if the number of comparison stars could be made indefinitely great.

To find the mean galactic motion, in this case, it will be necessary to make a critical study of the proper motions of the fainter and more distant white nebulae from which the apex of the motion of the Galaxy as a whole may eventually be recovered.

The accepted value of the Sun's motion through space has been derived from the relative motions of a few neighbouring stars, assuming that, on the whole, these are moving among themselves indis-

* "Old and New Astronomy," page 725.

† Vol. XXXV, page 31.

criminately in every direction; that is to say, the investigation of the parallactic and proper motions of the stars has hitherto proceeded on the assumption that the proper motion of a star is as likely to be in the direction of one of three rectangular axes as in any other, and consequently that, in a general average, the components of motion are equally distributed between the three axes. If the assumption is erroneous, the method fails, or at least requires extensive modifications. It has now been definitely ascertained that the assumption is wrong and that the stars are not moving indiscriminately. In 1905, Mr. F. W. Dyson announced the discovery of two great star-drifts which have been traced in his subsequent investigations through all parts of the sky. The stars belonging to one of these drifts diverge from R.A.=270°, D=+12°; and this drift has been mainly influential in the derivation of the accepted value of the solar apex. The other great drift diverges from R.A.=83°, D=+60°. The phenomenon has the appearance of an interpenetration of two great star streams coming from directions 110° apart.

As a consequence of this discovery, we must consider the possible alterations which it may impose upon the value derived for the solar motion. Stars in a stream whose motion is opposed to the Sun's movement, will open out more rapidly in the direction of the Sun's advance than members of the stream to which the Sun itself belongs. The latter may be advancing together on nearly parallel lines and with nearly equal velocities, and may thus maintain relatively fixed distances from each other and from the Sun, with an almost total absence of proper motion, although relatively near to us. The selection of stars having large proper motions as suitable candidates for parallactic determination may have to be revised in the light of this new conception. If stars without sensible proper motion are investigated for parallax with the same assiduity as those of large proper motion, we may perhaps find some near neighbours in this neglected group.

The phenomenon to which Proctor gave the name of "star-drift," has been known from a few isolated groups. The conception must now be extended. What we have done is to select a particular drift among stars of large apparent motion, which seemed to be somewhat general, namely, that in the direction of the constellation Argo, and to assign its cause to the motion of the Sun, and we call this the general parallactic motion; but there has been, until quite recently, no way of deciding which of these movements—that of the Sun in the direction of Lyra, or that of the other stars in the direction of Argo—is the real one; and no matter whether the peculiarity is one of solar motion or of solar rest, it is the Sun's own peculiar condition as compared with that of a considerable body of stars.

Now, seeing that other stars move in groups, is it reasonable to suppose that our Sun has no companions to share in a common drift? There is a great multitude of stars with scarcely any appreciable proper motion, including many stars which are fairly bright. Is it necessary to suppose that these are all at such a great distance that their proper motions are insensible on this account? May not a great many of them fall into one common star-drift with our Sun? If so, it is the "Argonauts" that are peculiar. Actually, the direction of stellar motion away from the solar apex may not be the predominant one. We begin to have evidence of this solar association. Professor Stroobant* has chosen stars with moderate annual proper motions (0″·00 to 0″·08), namely, α Cassiopeiae, β Persei, α Persei, α Scorpii, γ Cygni, ε Pegasi, α Pegasi and the Sun, and by combining the parallax, the motion in the line of sight and the proper motion, he gets a true picture of their system in space and finds that these eight bodies agree in the direction of motion within a range of about 6°, while their velocities range between 11·3 and 22·1 kilometres per second.

Professor Lewis Boss finds evidence of a great star drift towards R.A.=95°·6, D=−7°·5†, to which Mr. Benjamin Boss assigns a mean linear velocity of ninety-five kilometres per second. I understand that this investigation is merely a preliminary one. Since it rests upon the supposition that there is but one great drift, and that the direction and amount of the solar motion is that commonly assumed, the foundation becomes insecure, as soon as divers other drifts are admitted to exist. Mr. Benjamin Boss refers to the drift of "the Taurus group in the general direction of the vertex (inclined to it about 15°), and the Ursa Major group inclined about 18° with the antivertex,"‡ but the effect of these and other drifts upon the assigned solar motion is not considered.

Mr. H. C. Plummer gives preliminary data for several new star-drifts.§ He finds

	No. of Stars	Velocity km sec.	R A	Dec
Drift i. ...	22 ...	9·7 ...	65°·2 ...	−24°·4
" ii. ...	19 ...	37·9 ...	87°·0 ...	+ 7 ·3
" iii. ...	16 ...	21·6 ...	106°·1 ...	−52°·9
" iv. ...	13 ...	10·0 ...	317 ·2 ...	−23°·6

No. ii. agrees with Mr. Boss's value for the Taurus group which is shown to be "no mere localized cluster, but contains members which are scattered over the whole sky." No doubt many other drifts remain to be discovered.

(To be continued.)

* *Bulletin Astronomique*, November 1910, Vol. XXVII, page 433.

† *Astronomical Journal*, No. 629, page 33, November 20th, 1911.

‡ *Astronomical Journal*, No. 629, page 33.

§ *Monthly Notices Royal Astronomical Society*, Vol. LXXII, No. 3, page 170, January 1912.

NOTES ON THE DEVELOPMENT OF MONADIDEA.

By AUBREY H. DREW.

BIOLOGY is as profoundly concerned with the study of the smallest, as with that of the largest organisms, but the class Mastigophora deserves special attention from microscopists for many reasons. The discovery of the Trypanosomes, and their intimate relation to sleeping sickness and many other diseases peculiar to tropical regions, has concentrated a considerable amount of attention on the Trypanomorphidae, and numerous biologists are engaged in all parts of the world in working out their life-histories. The order Monadidea, which comprises the least differentiated forms of the Mastigophora, is well worthy of careful inquiry, as, although at present none of this order have been demonstrated to be the causative agents in disease, yet they are allied to the Trypanosomes, and in them we have a type of organism which is on the very fringe of organised life. The opportunities for discovering new and interesting forms are great, as the order has been very much neglected, and comparatively few of the organisms have been figured and described. Moreover, it is extremely desirable that we should possess a full knowledge of the life cycles of the Protozoa, and an excellent field is open in this direction to microscopists. It is not difficult, I think, to understand why this order has been so much neglected, as the organisms comprised therein are exceedingly minute and consequently escape the notice of the average amateur microscopist, unless he is provided with first class and high powered lenses. The professional worker is usually so taken up with organisms such as the bacteria that, even if he comes across the monads in the course of his researches, he has no time to spare for organisms that are not yet definitely connected with disease.

Again, to acquire any real knowledge of the development of these minute forms, it is necessary to spend long and wearisome hours of constant observation at the microscope, and the majority of workers prefer a study that does not tax their patience to the uttermost. It is, however, to the amateur, who has already done yeoman service to microscopic science, that we must look to work out these organisms, and with such a wide and little explored field before them it is much to be hoped that ere long our knowledge of these organisms and their wonderful life cycles will have greatly advanced. The Monads are universally distributed in water containing decomposing organic matter, either animal or vegetable. They are colourless flagellata, with from one to an indefinite number of flagella, and a single nucleus; they also possess a simple vacuole system.

METHODS OF NUTRITION.

The nutrition of the order may be holozoic, saprophytic, or parasitic, but probably never holophytic. Formerly, the Monads were regarded as essentially saprophytes, but increased knowledge of the order, and particularly a careful study of their life histories, has shown that almost invariably a certain amount of holozoic nutrition takes place at some period in the organism's development. In certain forms holozoic nutrition plays a very important part, saprophytism being reduced to a minimum. In the new monad, *Monas sarcophaga*, described by myself in "KNOWLEDGE," in November, 1910, holozoic nutrition is by far the most important means of obtaining food, and in this particular form the organism even goes so far as cannibalism. Some forms, and perhaps all, in a greater or less degree, are saprophytic, obtaining their nutrition from the water in which they live by absorbing the soluble disintegration products from the breaking down of complex protoplasmic molecules by bacteria. The food in these cases is predigested by the enzymes secreted by the various bacteria present. Most forms, however, combine a certain amount of holozoic nutrition with the saprophytic, these organisms being conveniently designated as Mixotrophic. With regard to these mixotrophic forms, bacteria and small protoplasmic particles, both animal and vegetable, form the food, whilst in the *Monas sarcophaga* other monads of the same or different species are ingested.

REPRODUCTION.

Two methods of reproduction occur in the Monadidea, a sexual and an asexual. As is the rule amongst the Protozoa, reproduction by fission is the commonest. Some appear to divide into many smaller forms, as first recorded by the late Dr. Dallinger. The nucleus in all cases appears to go through a karyokinetic process prior to division. This asexual process, however, does not appear to be capable of maintaining the perpetuation of the organisms indefinitely, and in probably all cases an anisogamic method of reproduction also occurs. This is almost always obscure, and can only be observed by continuous and repeated observation of the same form over a length of time. Dallinger recorded that he and Drysdale observed the same form continuously for five days before seeing any other method of reproduction than the asexual. In many, and possibly all cases, the spores which are formed in this method of reproduction appear to be more resistant to heat and other unfavourable conditions than are the parent forms, thus tending to keep the species from extinction. Dallinger and Drysdale recorded that in one form they studied, the parent organisms had a thermal death point of about 60°C, while the spores from the sac did not perish till a temperature of 149°C was reached. I have found also, in the case of the *Monas sarcophaga*, that the normal form dies at a temperature between 52°C and 55°C, while the contents of the sac formed by the conjugation of two forms withstood a temperature of 120°C for five minutes. This second method of reproduction does not in all cases appear to be truly anisogamic, for often the two conjugating gametes appear to be similar. In other cases the gametes may differ in some respects—generally, one is larger and more granular than the other. In the forms where holozoic nutrition is met with, a digestive juice of an acid nature appears to be secreted. In the *Monas sarcophaga*, which habitually ingests other monads, as well as bacteria, I have shown that bacilli stained with blue litmus are almost instantly turned red after ingestion. In this particular organism this secretion appears to act with great rapidity, the edges of the ingested organism being speedily corroded, till only a small portion of undissolved material is left, which the monad finally expels.

FIGURE 360.
Normal free-swimming form.

FIGURE 361.
First stage in reproduction by fission.

STRUCTURE.

The structure of the monads is simple. They do not appear to be divisible into an ectoplasm and an endoplasm, like the Amoeba. The organism usually consists of transparent protoplasm, with granules embedded therein. Some of these granules are probably of a fatty nature, staining black with osmic acid. All the monads possess a nucleus, which is at times specially prominent. Even in the holozoic forms no mouth opening or anus is present, but in some species food particles are ingested at certain fixed points, usually at the base of the flagella, whilst undigested matter may be expelled from any point in the body, but usually from the opposite end to the flagella.

FIGURE 362.
Second stage in reproduction by fission.

METHODS OF STUDY.

A few words on the methods adopted in the study of these organisms may be useful. The microscope used for this class of work must be a firstrate one. It should have a tripod foot, and be perfectly steady in any position. A mechanical stage and compound substage are absolutely necessary. The microscope that I have used exclusively for my researches on these organisms is one of Messrs. Watson's instruments, and although it has been in daily use for over four years I have not found it necessary to make the slightest adjustment. With regard to lenses, these need not be numerous. The objectives I have found to be of most utility are the half-inch, one-sixth inch, and one-tenth inch dry, and one-twelfth inch homogeneous immersion. A high-powered dry lens is essential for a large part of this work, as an immersion lens is objectionable when following a rapidly swimming organism for many hours. The one-tenth inch dry lens that I have used for some time was made by Watson's, and is an excellent lens for this work, possessing the three necessary requisites, *viz.*, excellent definition, capability of bearing a large solid cone from a good condenser, and ability to take high eyepiecing. The condenser used should be an achromatic one, the Abbé Illuminator being useless for critical work. The first requisite is some means of keeping a minute drop of fluid, containing the organisms, continually moist, and to prevent evaporation. Perhaps one of the best means is that devised by the late Dr. Dallinger, and described in "The Microscope and its Revelations." A very good arrangement I have used and which possesses the advantage of allowing several objectives on a revolving nosepiece to be used rapidly, is the following. A piece of thin cardboard has a circular hole cut out of it, and the card is then cut to a slightly smaller size than the ordinary three-inch by one-inch slide. This prepared card is then soaked in water, the excess of water removed, and the card placed upon a glass slide. Two cover glasses are used, one slightly larger than the hole in the card, the other being quite small, say three-tenths of an inch in diameter. The drop of fluid to be examined is placed between these cover glasses and they are then placed on the card, the smaller cover glass being undermost; if a small vessel of water is now placed in connection with the card by means of filter paper the preparation may be kept for weeks without evaporation from the fluid under examination. It is almost impossible to get good permanent dried preparations of the monads, as if dried on a cover-glass, like bacteria, they break up, and the same result occurs if fixing agents are used; hence it is extremely difficult to photograph the organisms, and recourse must be

FIGURE 363.
Third stage in reproduction by fission.

FIGURE 364.
Resting stage prior to conjugation.

FIGURE 365.
Conjugation.

had to the "Camera Lucida." Movement may be stopped by very dilute solutions of cocaine hydrochlorate. The drawings illustrating the life history of the monad herein described were done by means of a Camera Lucida and Watson's "Holoscopic Immersion Paraboloid" which gives excellent dark-ground effects with high-apertured lenses. Whilst engaged in working out the life history of the *Monas sarcophaga* I frequently observed small organisms somewhat resembling this monad, but of considerably less size and possessed of a peculiar jerky motion in swimming. The difficulties in working out this organism's life history were not a few, but at length I have been able to accomplish it. This monad is an entirely new one, and on account of its peculiar vibratory motion in swimming I have named it *Monas vibrans.* This organism is closely related to, and belongs to the same sub-tribe as the *Monas sarcophaga, viz.*, the Paramastigoda. It varies slightly in size, but not nearly so much as the *Monas sarcophaga*, the average size being about one four-thousandth of an inch in length. The shape is bluntly triangular or conical, and the organism is very granular. It possesses two flagella, one long and one short (hence Paramastigote). The long flagellum is not as long in proportion to the body as that of the *Monas sarcophaga*, and is bent round somewhat like a fish hook; the small flagellum, which is exceedingly minute, and generally rather difficult to observe, arises from the base of the long one, and on its convex side (see Figure 360). A nucleus, which stains somewhat irregularly with Haematoxylin, and a contractile vacuole are present. Swimming occurs by lashing of the long flagellum, aided by the smaller one. The long flagellum is vibrated with a peculiar whip-like motion which makes swimming very jerky and irregular. On following one of these forms by means of the mechanical stage, never losing sight of it in all its wanderings, it is found after a varying period to come to a standstill, and to adhere to the slide, apparently by means of a pseudopodial appendage. On coming to a rest, the long flagellum is vibrated with great rapidity, thus causing small protoplasmic particles and bacteria to be swept towards the monad, many of which on touching the body, near the flagella, are engulfed by an amoeboid action of the protoplasm. This stage of feeding may last for hours; in fact, the monad spends a large part of its existence in feeding in this way, swimming about at intervals apparently in search of pastures new. After some time two new flagella slowly appear near the normal pair. At first, these are very minute but rapidly grow larger and are in intense vibration; they swiftly diverge and at length get to the opposite pole to the normal pair. During this duplication of the flagella, the nucleus of the organism has become strongly developed and a division takes place; one of the two daughter nuclei now passes into each polar region, and with the two pairs of flagella now pulling from opposite ends a constriction suddenly appears across the body of the monad. From this time onward the constriction rapidly deepens, the two pairs of flagella pulling the organism into an hour-glass shape, shown in Figure 363. Finally, only an exquisitely-fine strand of protoplasm connects the two halves; this strand gradually gets thinner till at length it snaps, and the two organisms go free. Usually one of the two remains in the place where division took place, and at once commences to feed, while the other swims about for a time, till it also becomes stationary, and commences feeding operations. In a few instances I have observed feeding to go on during the actual process of division. The time occupied in this division is usually from fifteen to twenty minutes. For many months this was the only method of reproduction which I could observe. At length, however, I found that a certain proportion of the organisms, after swimming and feeding in the manner already described for many hours, became very sluggish and usually sank to the bottom of the drop of of fluid under examination; the flagella lashed feebly, and the body of the monad became very pale and rather indistinct, the nucleus becoming considerably more prominent than usual and situated towards the posterior end of the monad. In several specimens I have noticed that the nucleus became somewhat striated at this stage. Finally, the flagella ceased movement, and the whole organism was perfectly motionless. At first, I came to the conclusion that some deleterious influence had killed the monad, and it was only after I had again and again failed to find any other method of reproduction than the asexual, that I determined to study these motionless forms further. A peculiarity of this monad is the length of time that it may remain in this quiescent condition. In four specimens I observed the average

FIGURE 366.
First stage in formation of sac.

FIGURE 367.
Second stage in formation of sac.

FIGURE 368.
Sac discharging spores.

FIGURE 369.
Spores after four hours growth.

FIGURE 370.
Sedentary form feeding.

duration was about three and a half hours. The flagella then suddenly commence to lash again, at first very feebly, but finally rapidly, and the organism swims off. During the quiescent period, the body of the monad has become swollen and very pale, and the nuclei is dense and glistening. These organisms now swim about with great rapidity. If one is now carefully followed, it will be found, after a varying lapse of time, to seize on one of the normal forms, to which it adheres, violent lashings of the flagella taking place. It is soon evident, however, that the larger organism is absorbing the smaller. Finally, this is accomplished, and very soon after this the monad, or more properly speaking the product of the fusion of the two organisms, comes to a standstill, rapidly gets globular, the nuclei disappearing and the flagella melting into the sarcode. A motionless globular sac is now left, of a slightly yellowish colour. The time the sac remains in this condition apparently varies a good deal, perhaps owing to temperature, but thirteen to fifteen hours seems about an average. It then suddenly and without the slightest warning bursts, and a glairy fluid, containing excessively minute granules, is poured out. These granules at first show only Brownian movement, but later (about three hours) they grow somewhat larger, and then exhibit amoeboid movements. From this time they rapidly grow larger, minute flagella are developed, and they swim away, small but perfect counterparts of their parents. It will be seen that this organism, both in its microscopic appearance and development, bears a striking resemblance to the *Monas sarcophaga*. It is easily distinguished, however, by its much smaller size, and the difference in the flagella. The average size of these organisms is very uniform, whilst the *Monas sarcophaga* shows considerable variation. Although I have specially and carefully looked for it, I have never found this monad to ingest other monads either of the same or different species. This, I think, is to be accounted for by two reasons. Firstly, the small size of the organism, and secondly, the flagella being smaller, do not appear to set up sufficient current to draw bodies of much greater size than bacteria towards the monad. A large number of these organisms furnish the *Monas sarcophaga* with food, and on several occasions I have had many hours' work spoilt by the monad under investigation finding a grave within the body of the former organism. Both these monads are, I believe, found exclusively in putrefying vegetable infusions and ponds in which much vegetable matter is in process of decomposition. The *Monas vibrans* multiplies far more freely and rapidly than the *Monas sarcophaga*. Both organisms may be cultivated in infusions of grass, but both rapidly die out as soon as the larger infusoria appear. The *Monas vibrans* almost invariably disappears from an infusion before the *Monas sarcophaga*, and from a large number of experiments I have come to the conclusion that both these organisms produce substances in the culture medium, which act deleteriously on them, and ultimately inhibit growth. I have recently found that if a quantity of an old culture, in which the organisms are dying out, be exposed to a temperature of 60° C. and then filtered, the filtrate possesses markedly toxic properties towards these monads, a minute quantity added to a hanging drop preparation soon causing death. I am inclined to think that the toxic substances are of the nature of ferments, though at the present stage of my researches I cannot bring forward any direct evidence to support the view.

CORRESPONDENCE.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

Sirs,—In a reply to Mr. Annison's article on the Fourth Dimension appearing in your issue for July, 1912, I notice a reference to a letter of mine on the subject which appeared in "KNOWLEDGE" for August, 1911. This letter merely called attention to an argument I had propounded in favour of the real existence of the fourth and higher dimensions in an earlier issue of "KNOWLEDGE," and had more fully stated in Chapter VI of a work of mine entitled "Matter, Spirit and the Cosmos" (Rider, 1910). I gather from his remarks, however, that Mr. John Johnston, the writer of the reply to Mr. Annison's paper in question, has merely read my letter appearing in "KNOWLEDGE" for August, 1911, and has not consulted the statements of my argument therein referred to. It seems to me very unwise, to say the least, to venture a criticism of an argument with which one is not acquainted. It is, of course, obvious, to use Mr. Johnston's illustration, that a third apple on a boy's table does not imply the existence of a fourth; but then, the existence of one apple on a boy's table does not imply the existence of a second, nor does the existence of a second imply that of a third. The case, however, is altogether different with regard to the dimensions of space; for it can be argued, as I have shown in the places referred to, that the existence of one dimension of space does imply that of a second, and that the existence of a second dimension does imply that of a third. By the principle of the continuity of law, or the uniformity of nature, or whatever one likes to call it, then, the existence of a third dimension implies that of a fourth, and so on *ad infinitum*. This principle, I would remind Mr. Johnston, is a most valuable one, and has led to many valuable discoveries. It consists merely in the assumption (which the whole of our growing experience warrants) that a law holding good in the case of phenomena entering into our experience, holds good also in the case of phenomena which do not as yet, and perhaps never will, enter into our experience. It is the principle, for example, which enables us to predict the rising of the sun to-morrow, and, in fact, lies at the root of all natural science.

Thanking you in anticipation for affording this letter the hospitality of your columns.

H. STANLEY REDGROVE.

THE POLYTECHNIC,
REGENT STREET, W.

CELESTIAL MOTIONS CONSIDERED ON THE PRINCIPLE OF RELATIVITY.

By COL. E. E. MARKWICK, C.B., F.R.A.S.

IN astronomical text-books and popular works on the science one frequently, and naturally, meets with references to the enormously swift motions of celestial bodies, as compared with terrestrial experience. We read of the great comet of 1882 "rushing through the part of its orbit closest to the Sun," and the fixed stars are described as in reality "flying through space" at enormous velocities of varying direction and amount. One recalls how, in old schooldays, when "doing globes," the master would ask the question, "How fast is the Earth moving in its orbit?" and the pupil would answer, "Rather more than sixty thousand miles an hour." The first time one heard this it sounded as something startling, but the youthful mind cannot easily apprehend such an enormous speed, and by repetition the fact got to lose its significance. All these statements of high speeds are, of course, true, being based on a solar parallax which is now almost certain to the first decimal, combined with observed motions of the heavenly bodies.

Sir R. S. Ball, a most lucid expositor of celestial facts and figures, remarks in "The Story of the Heavens," on the motion of the Earth: "It will appear that the earth must actually complete eighteen miles every second. Pause for a moment to think what a velocity of eighteen miles a second really implies. Can we realize a speed so tremendous?" He then goes on to compare the motion of the Earth with that of an express train, travelling at the regulation text-book speed of sixty miles an hour, so that the speed of the train "is not even the one-thousandth part of the velocity of the Earth in its orbit." But he continues: "Viewed in another way, the stupendous speed of the Earth does not seem immoderate. The Earth is a mighty globe, so great, indeed, that even when moving at this speed it takes about eight minutes to pass over its own diameter. If a steamer required eight minutes to traverse a distance equal to its own length, its pace would be less than a mile an hour." A figure is given, showing two equal circles joined by a straight line, the distance between the centres being about six times a diameter of the circle. If this represents the Earth at two stages in its path, then "the time required to pass from one position to another is about forty-eight minutes."

The particular point now is to consider some of these enormous, and, to our experience, utterly transcendental speeds, relatively to the size of the moving body, because they then begin to assume a different aspect. A sense of proportion must be brought to bear on the matter, and actual terrestrial motions and dimensions must be more or less kept in their proper sphere when studying the order of motions and dimensions of the solar system as a whole. *Apparent* motions, however, are common to whatever position we are in, or may imagine ourselves to be in. Apparent motion, or, as it may here be termed, angular motion, is the speed at which a body moves across the field of view, irrespective of its distance. If we imagine anyone (call anyone an "ether-man," someone above an "air-man" in powers and qualifications), occupying an isolated position in space, it must still be with this corporeal frame, with a pair of eyes to see, and a celestial object to be seen. The rotation of the ether-man's body round its longer axis still sweeps out a field which is measured by three hundred and sixty degrees for a complete rotation. This conception holds good, even if deprived of the terrestrial horizon.

For the present purpose it seems convenient to fix on some limit of angular speed, below which, at the first glance or so, a body seems to have no motion. It is rather an arbitrary proceeding, but may serve for illustration. Put this limit at a rate of transit of 10° in five minutes of time, or 2′ of arc in one second; *i.e.*, three hours for the tour of the whole horizon. With this angular speed, a terrestrial object at one hundred yards distant from the observer would have to move at the rate of two hundred and thirty-one yards per hour; at two hundred yards, four hundred and sixty-two yards per hour; at one mile distant about two and one-third miles per hour; and at ten miles distant twenty-three miles per hour. For celestial observation, consider an object moving at a less angular speed than this, as seen with the naked eye, to be devoid of visible motion; if it moves faster, then say it has visible motion.

The angular motions of the planets round the Sun, and of the satellites round their primaries, are, of course, far below the limit just fixed. Seen from the sun, Mercury moves about 0″·17 in one second, the Earth 0″·04, Neptune 0″·00025. Turning to the satellites, the rapid Phobos, with its period of seven hours thirty-nine minutes fourteen seconds, moves 47″ in one second. Take, again, the case of a comet moving very close round the Sun. The comet of 1843 is stated to have described the whole of the segment of its orbit North of the plane of the ecliptic, in a little more than two hours. This implies an angular velocity of about 90″ per second. All these rates of motion are below, and most far below, the hypothetical limit.

What then, would a view of the solar system reveal to the ether-man, placed in space at a point high above the ecliptic. *Above* the ecliptic is, of course, a *façon de parler*, for there is no up or down, as we use the terms, in celestial matters; what is meant is, on that side of the ecliptic plane in which the north pole of the earth is situated. Let this point be somewhere about twice the diameter of Jupiter's orbit "above" the Sun, so as to open out his orbit and those of the planets within. Imagining our friend gifted with the necessary keenness of vision, at a casual glance the whole of the planets would seem to him to be at rest. There they would be, hung in space, apparently fixed points of light. It would be the same with the several families of satellites, supposing the observer could visit each of the mother planets, and note the outlook thence, as he studied the children of each. With the exception of a few of the satellites he would have to watch some little time before the motions of each system could be detected. Even a few stray comets would appear quite motionless in the inter-planetary spaces. All this is on the proviso that the observer has no telescope, but is watching things with ordinary unaided vision.

The same remarks apply with more force to the stellar system. Here, there is not so much need to move from the earthly point of view, as the Earth is surrounded by the stellar universe in all directions. And what is observed? The configurations of the stars remain practically the same from age to age. For thousands of years the old historic constellations have presented much the same shaped groupings; yet it is certain that every star is in motion—all have their proper motions—moreover, there are streams and classes of motions which individually, and taken absolutely, are of immense magnitude. The real motions of individual stars are known to range from ten miles up to forty or fifty miles per second, and in one case two hundred miles per second. All the while their apparent angular motions are extremely small. The principle of relativity must be borne in mind, and then it is seen that if the movements of the stars are compared with their enormous distances apart, the former are really quite slow and gradual.

Absolute terrestrial movements may, of course, be compared arithmetically with celestial ones, but to really grasp the enormous disparity between them is another matter, seeing we are dealing with speeds beyond our own experience. However, an effort may be made to discuss the case of the Earth's orbital motion, compared with that of an express train, as best representative of each class. Such motions as those of a rifle bullet or projectiles discharged by heavy ordnance, as well as molecular motions connected with light, electricity, and so on, are purposely left out of account. Everyone knows the terrific rush and momentum of a train travelling at sixty miles an hour, as seen from the platform of some country railway station, about twenty feet from the rails. A cloud of steam is first noticed and a distant roar heard, which rapidly increases in intensity. In the course of a few seconds, with a sense of momentum which thrills the spectator, the train, weighing hundreds of tons, dashes by, a wind follows, filling up the vacuum thus caused, and all is over.

Suppose, now, a position is taken up, on a clear day, on some elevated ground, such as the southern spurs of Dartmoor, or the South Downs in Sussex, some miles distant from the railway. From such a point the same express may be watched with a field glass, wending its way along the valleys and over the viaducts of the lower district. How the apparent motion is now reduced! There is the long trail of steam, but by comparison the train seems to crawl along in the distance. It is brought home to one that the sense of motion of a body depends on proximity to it.

This idea is well expressed in the following lines from a poem on the South Downs by Mr. R. Bridges, the reference being to steamships in motion, seen a long distance away.

> I climb your crown, and lo! a sight surprising
> Of sea in front uprising, steep and wide:
> And scattered ships ascending
> To heaven, lost in the blending
> Of distant blues, where water and sky divide,
> Urging their engines against wind and tide,
> And all so small and slow,
> They seem to be wearily pointing the way they would go.

So much for an example of terrestrial speeds.

Is it now possible to place the ether-man so that he can satisfactorily observe the Earth which moves one thousand times as fast as the express? To begin with, the moving body in this case has a diameter of some eight thousand odd miles, and he must be situated, at the very least, four thousand miles from the centre line of the Earth's track, if only to avoid collision, if such can be imagined between an atom of a being and such a vast globe. To get anything approaching a reasonable view of the motion, proportionate, in fact, to the conditions of position at a railway station, he must be placed about twelve thousand miles from the centre of the track. But seen from this distance the Earth's motion would seem comparatively slow: for, as Sir R. Ball says, it would take eight minutes to pass over its own diameter, which from the selected point of view would subtend an angle of about thirty-nine degrees. This corresponds to an angular rate of motion, when near the spectator, of about 5′ a second. This rate, which is certainly above our limit, is yet not fast, corresponding to a body at one hundred yards distance moving across the field of view at a speed of about one-third of a mile per hour. At the first glance the Earth would seem to be moving very slowly, in fact more or less "poised in space." Morally speaking, it is pretty certain that no human being could see such a sight—and live.

So far, motions of revolution only have been considered, but motions of rotation of the planets, although much more rapid, are still below our limit. A person on the Earth's equator, we know, is whirled round, in space, at an absolute speed of over one thousand miles per hour. Yet on account of the smoothness of the motion, and every surrounding object, houses, hills, valleys, ocean, atmosphere and clouds moving together, the speed is not appreciated; it is not even experienced. To try for a sense of it, the ether-man must get away from this terrestrial ball at least ten thousand miles, and then the Earth would at the first glance appear motionless, in the matter of rotation. His success would be no better than in his endeavour to watch the speed of the Earth in its orbit.

Hence it may be inferred that although the motions of the solar system, taken absolutely, quite transcend terrestrial molar motions, yet considered relatively to the dimensions of the system they are not what would be termed rapid—far from it. The angular motion of a body round a centre of gravitation is governed by the Keplerian laws: the nearer to the centre, the more rapid the motion. But even in the extreme case of a body revolving round the Sun, just skimming its surface, and of a body doing the same round the Earth, the angular speed is slower than the limit fixed on.

There is one class of bodies, of a semi-celestial nature, of which no account has here been taken, and which, perhaps, occupy an intermediate position, in the matter of motion, between the planets and the Earth, *viz.*, meteors. Here we have a comparatively minute object moving through the atmosphere at a planetary rate, or something approaching it. Owing to comparative proximity, the great speed of a meteor can better be appreciated than the motion of bodies enormously further away. It is far in excess of the limit, the body covering twenty degrees, thirty degrees, or more, of the field of view in a very few seconds. But do we then really grasp the meaning of fifty miles a second, which is the speed of many meteors? If one were really very close to a meteor it could hardly be seen as it passed by, except in the form of a flash of lightning, because its flight is so enormously swift. Yet in the inter-planetary spaces, a swarm of meteors (if their visibility is possible) would at the first glance seem motionless, if viewed from a distance sufficiently great to enable the whole swarm, or ring, to be included in the field of view.

It seems clear, then, that celestial motions take on a different aspect when considered with due regard to the dimensions of the bodies concerned, and the distances which separate them.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

SPECTRA OF FAINT STARS.—Not very much has been done as yet under this heading, but Professor Hale (of Mt. Wilson) has promised to give the preference to Professor Kapteyn's selected areas in his researches. The general type of spectrum of the fainter stars may be inferred by comparing their magnitude on ordinary plates with that given on red-sensitive plates. A series of the latter plates will be taken at Johannesburg by Mr. Innes, and there is a prospect of a corresponding series in the Northern Hemisphere.

It is well known that the proper motions of the brighter stars show a variation depending on spectral type, and it will be of interest to extend the investigation to much fainter stars. Miss Cannon, of Harvard, gives the following average proper motions of stars of magnitude 5·00.—

Spectrum.	Galactic Latitude ± 20 to ± 90: Average Proper Motion.	No. of Stars	Galactic Latitude + 20 to − 20: Average Proper Motion	No. of Stars
B	0″·021	1	0″·028	9
B5	·025	72	·024	113
A	·062	84	·049	110
A5	·101	38	·067	27
F	·162	38	·091	18
F5	·234	25	·135	10
G	·308	19	·306	11
G5	·357	25	·302	15
K	·139	117	·123	61
K5	·081	12	·042	6
M	·071	15	·029	5

The table shows that stars of the B or helium type are very distant, while those of the G or solar type have much larger proper motions, and are our nearer neighbours.

RADIAL VELOCITIES.—"On Mount Wilson the focal plane spectrograph has produced in a short time an astonishing number of radial velocities of faint stars. The probable error of velocity of a seventh magnitude star with good lines is 0·9 kilometres per second. A solar star of sixth magnitude requires twelve minutes exposure, seventh magnitude thirty minutes, eighth magnitude seventy minutes." Professor Pickering has been making experiments on deducing radial velocities from plates taken with objective prisms, using the Neodymium absorption line. The probable error is over eight kilometres per second, but for statistical purposes this is not serious and is counterbalanced by the wholesale accumulation of material.

Owing to the small absolute velocity of the B or "Orion" stars an attempt was made by Kapteyn and Frost to deduce the solar motion from these stars alone. The curious result was obtained that stars near the Apex gave a solar velocity that differed ten kilometres per second from that given by stars near the Antapex. It was at first surmised that this arose from groups of "Orion" stars having systematic motions of their own, but further research appears to have negatived this suggestion, and the report now gives as the explanation the shifting of spectral lines due to pressure. If this shifting is really so great, it is obvious that many of the published results of radial motions will need revision.

BRIGHTNESS OF THE BACKGROUND OF THE SKY.—Mr. Yntema, of Groningen, has made some important investigations in this field. He finds that the skylight, even on the darkest night, is not wholly due to starlight, but arises in our own atmosphere, perhaps from a permanent aurora. In spite of this obstacle, useful observations of the total amount of starlight are being obtained. Professor Abbot has made some observations on the top of Mount Whitney (fourteen thousand five hundred feet high), to diminish atmospheric illumination. The results are not yet to hand.

It will be seen from these extracts what a large number of collaborators are engaged in work on these selected areas. While the full completion of the plan will be a work of many years, preliminary results of interest are already appearing. The whole scheme reflects great credit on Professor Kapteyn's energy and foresight, and illustrates the value of method in bringing about a rapid advance of our knowledge of the structure of the Universe.

It is incidentally mentioned that Professor Kapteyn is revising the star magnitude of the Cape Photographic Durchmusterung, and that it will soon be possible to refer these to the standard Harvard system, which will greatly increase their value.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

ORIGIN OF VASCULAR PLANTS.—Although Professor Campbell does not in his memoir (on the Eusporangiatae mentioned in last month's "KNOWLEDGE.") discuss the wide question of the origin of the vascular plants as a whole, he re-states the arguments which he has already brought forward in support of his view that *Ophioglossum* represents the most primitive living vascular plant, and that it is connected with the Bryophytes (liverworts and mosses) through the remarkable *Anthoceros* group, which is usually classified with the liver-worts, though differing from all other Bryophyta in some respects.

Setting aside the question as to whether the Ophioglossales or some other Pteridophyte group (such as the Lycopods) are to be regarded as the most primitive of vascular plants, there are several possible views regarding the origin of the higher plants. Of these, the one which has been so ably urged by Campbell himself is that from some form like *Anthoceros*, in which the spore-producing generation remains with its lower portion embedded in the sexual plant, the free-living spore-producing plant of a simple Pteridophyte, not unlike *Ophioglossum*, may have arisen. The first, and perhaps the most important, step required is the production of a root. The sporogonium of *Anthoceros* obtains water and salts from the simple thalloid sexual plant by means of a swollen absorbing organ or foot; above this there is a zone of active tissue, which for a long time adds fresh tissue to the long cylindrical capsule above; through the capsule there runs a central bundle of elongated cells, and the spores are produced in a zone between this and the several-layered capsule-wall, which contains abundant chlorophyll and bears stomata. Apart from its supply of water and salts, which are derived from the sexual plant, the *Anthoceros* sporogonium is self-supporting; if it produced a root and sent this into the soil, it would become wholly self-supporting, and we should, in fact, have something comparable to a simple form of *Ophioglossum* in general organisation. In the case of the existing species of *Ophioglossum*, the simplest type (*O. moluccanum*) has no definite stem, and consists simply of leaf and root. The young sporophytes of *Anthoceros* and *Ophioglossum* show considerable resemblance, both having a massive foot, while the spore-capsule of the former is represented in the latter by the first leaf or cotyledon. Campbell regards this cotyledon, now sterile, as having been, in an ancestral "pro-*Ophioglossum*" a fertile structure.

While one might point out a considerable number of detailed differences between the Anthocerotales and even the simplest of the known Ophioglossaceae, one must admit that this striking hypothesis of a direct connexion between the Bryophytes and *Ophioglossum* involves, on the whole, less formidable assumptions than those which confront the other theories put forward to account for the origin of vascular plants.

INTENSIVE ECOLOGY.—In "Boden und Klima auf kleinstem Raum," published by Fischer of Jena, G. Kraus has produced an admirable work which will doubtless lead to similar researches on various types of plant-habitat. The perusal of much of the literature of Plant Ecology hitherto produced, leaves one very sceptical as to the soundness of the foundations upon which many of the conclusions put forward are based, and for this reason one welcomes the increasing number of memoirs dealing in detail with some selected habitat and analysing as minutely as possible the various factors of the environment—in short, attempts at what may be termed "intensive Ecology."

Kraus first deals with the influence of the lime-content of the soil in his district (Karlstadt-on-Main), upon the flora, and gives the results of analyses, showing the composition of the underlying rocks (sandstone, chalk, loess), subsoil, and soil; the carbonate content at different depths in the substratum and in areas inhabited by different plants; the lime-content of the various plants themselves, and so on. From these analyses he finds that none of the plants examined occur exclusively on a substratum of approximately equal lime-content; but on the other hand some species "prefer" a high percentage of lime and others a low percentage. Among the characteristic species of the sandstone areas, usually free from chalk, there occur chalk-loving plants in places where some lime is present; in these places the lime-content is usually much lower than in the normal habitats of these plants, and characteristic chalk-plants with high lime percentage do not grow in such places. Where the sandstone merged into the limestone the author found some cases of typical chalk-plants, like *Hippocrepis* (Horse-shoe Vetch) and *Pulsatilla* (Pasque-flower), growing in places where calcium carbonate was entirely absent; while "calcifugous" (chalk-avoiding) plants, like *Vaccinium* (Bilberry) and *Calluna* (Ling), were found in spots where a fair percentage of chalk was present. In fact, excepting for a few plants which apparently need large amounts of carbonate of lime, Kraus found most of the "calcicolous" species on soil quite free from carbonate, and he concludes that it is not the calcium carbonate, but the physical characters of the soil, that can explain the distribution of the plants.

Of course, the facts that various "chalk-plants" may be found on soils free from calcium carbonate, and that on the other hand species which usually avoid lime may occur here and there on chalk or limestone, have frequently been observed; where calcium carbonate rocks (chalk and limestone) occur alongside of non-calcareous rocks, this wandering of the plants from calcareous to non-calcareous soils appears to be fairly common. Kraus sets out to explain this, and suggests that the most important factors are the dryness and warmth of the chalk-soil. He proceeds to investigate in detail, with elaborate tables, the physical characters of the substratum—soil structure, water content, temperature, relation of soil temperature to air temperature, air temperature at different heights above the surface, atmospheric humidity, and wind. From his careful observations on these points, Kraus concludes that the chalk substratum is by no means uniform, but is a most complex mosaic of parts differing chemically and physically. Each of these parts has its individual characters—its own climate, in the widest sense. Kraus emphasizes the importance of the structure of the substratum, upon which depend the water-content and the temperature, and which determines above all else the nature of the habitat. Among other interesting observations, he points out, as illustrating the dependence of air temperature upon soil temperature, that the temperature is highest at the surface of the soil, and that from this point it diminishes during the day both above and below, while at night it increases upwards and downwards.

ROOT-NODULES IN NON-LEGUMINOUS PLANTS.—Two interesting papers on the structure of bacterial root-nodules in plants not belonging to the family Leguminosae (in which such nodules are apparently always found) are published in the *Annals of Botany* (XXVI, January, 1912) one by Professor Bottomley on the nodules of bog myrtle (*Myrica gale*), and the other by Miss Spratt on those of an alder (*Alnus incana*) and two species of Elaeagnus (*E. edulis* and *E. rhamnoides*).

In *Myrica* the root-nodules are modified lateral roots. The young primary nodules give rise, by branching, to the characteristic cluster-nodules, surrounded by rootlets which grow out through the end of each branch; three branches or secondary nodules arise from the end of each primary nodule, and like it are modified lateral roots; then the central cylinder of the primary nodule elongates and grows through the apex of the nodule, giving rise to the hair-like rootlet. In each mature nodule four zones can be distinguished: (1) the apical meristem; (2) the infection-thread area; (3) the bacterial zone, which includes most of the cortical tissue of the nodule, and consists chiefly of the enlarged cells containing bacteria; (4) the basal zone—the lower end of the nodule, devoid of bacterial cells, but containing numerous cells filled with oil-drops. After the nodules have branched and reached their full size the bacteria disappear from the bacterial zone, and the basal zone gradually encroaches upon and finally replaces all the other zones. Pure cultures of the bacteria were made, and were found to be identical with *Pseudomonas radicicola*, the organism of the root-nodules of Leguminosae. Young *Myrica* plants grown in sterilised nitrogen-poor soil did not flourish unless they possessed root-nodules; plants devoid of nodules, after infection with a culture of *Myrica* nodule bacteria, developed root-nodules and grew well.

The nodules of *Alnus* and *Elaeagnus* are modified lateral roots, and are perennial structures showing dichotomous or trichotomous branching. They are produced by the infection of the root with the nitrogen-fixing organism *Pseudomonas radicicola*, as in the case of *Myrica*, which enters the root and propagates itself in the cortex as a rod-shaped organism—in *Elaeagnus* it produces a definite zoogloea in the form of a thread-like jelly in which the bacteria are imbedded. The further development of the organism, in both *Alnus* and *Elaeagnus*, gives rise to relatively large spherical bodies, which multiply until they fill the entire cell; under certain conditions these bodies divide into two, then each divides again, until they lose their identity and a group of bacilli remains in their place. Apparently *Pseudomonas radicicola* is polymorphic, the bacillus (rod-like) and coccus (spherical) types being different forms of one and the same organism. In *Elaeagnus* the bacteria are found mainly in the region immediately behind the growing-point; in *Alnus* the bacteroidal tissue traverses the entire length of the nodule. In *Elaeagnus* the food storage cells are found towards the base of the nodule; in *Alnus* there are zones of tissue concentric with the endodermis; in both, the endodermis performs this function. The coccus is apparently correlated with scarcity of available carbohydrate and change of environment; it is much more resistant to the influence of external agencies than the rod-shaped form. The organism is capable of fixing free atmospheric nitrogen when isolated from the nodules, and its presence is undoubtedly beneficial to the plant.

MOLDENHAWER'S WORK: PLANT ANATOMY A CENTURY AGO.—Probably few botanists have noted the fact that this year marks the centenary of the publication of one of the most important works in the history of this science. After the appearance of the classical memoirs by Malpighi (1675) and Grew (1682), which laid the foundation of vegetable anatomy towards the end of the seventeenth century, very little further advance was made in this branch of Botany for over a hundred years. During the interval between Grew's work and that of Moldenhawer, it is true, some interesting contributions were made by Casper Wolff (1759), Hedwig (1782), Mirbel (1802), Bernhardi (1805), and Treviranus (1806). As Sachs justly remarks in his "History of Botany," Bernhardi's observations are decidedly the best in the whole period from Malpighi and Grew to Moldenhawer: for instance, he distinguished pith, bast, and vessels, regarding them as the three chief forms of vegetable tissue, and he correctly explained the structure of spiral and annular vessels. Treviranus discovered the intercellular spaces in parenchyma, though he thought they contained sap and even described its movement.

Johann Moldenhawer (1766–1827) went far beyond his predecessors and contemporaries in the study of plant structure, both as to his actual observations and the accuracy of his interpretations. He first hit upon the happy idea of isolating cells, vessels, and fibres from plants by maceration in water, though he still relied upon somewhat primitive methods—for instance, he mounted delicate microscopic objects in a dry state and simply crushed or picked his preparations to pieces instead of cutting sections and mounting them in water, though the importance of the latter procedure had already been pointed out by previous workers. His best microscope was an English instrument made by one Wright, and gave a magnification of about four hundred diameters. Besides making good use of his maceration method, which enabled him to study the forms of cells and vessels and to make out the structure of these tissue-elements, and the sculpture on their walls, more accurately than had been done before, he made the fortunate choice of working largely with the maize plant, instead of using the complicated and difficult woody stems which had so greatly puzzled the earlier investigators. Moldenhawer laid chief stress from the first on the contrast between the vascular bundles and the cellular ground-tissue, and thus hit upon a fundamentally important fact which set later workers upon the right track. Even more brilliant was his study of the structure of the stem in Dicotyledons, to which he next proceeded, for he was the first to see that the growth of the woody stem can only be understood from the structure of the young parts of the stem, in which there is a ring of isolated bundles. All previous vegetable anatomists had adopted Malpighi's theory of the growth of woody stems—that the outer layers of wood arose by transformation of the inner layers of bast. Moldenhawer, after carefully comparing the structure of young and old stems, rejected this view and thus removed an ancient error which soon afterwards disappeared from botanical literature. This service alone entitles him to an honourable place in the history of Botany. He was the first to demonstrate the real nature of the stomata on the surface of leaves, showing that these are not simply holes in the outer walls of the epidermis cells but apertures leading into the interior of the leaf and surrounded each by two guard-cells.

Moldenhawer's *magnum opus*, and apparently his only work, is a quarto of three hundred and eighty-four pages, entitled "Beytrage zur Anatomie der Pflanzen," and contains six plates of remarkably accurate and well-executed drawings. It was published at Kiel, where he was Professor of Botany, in 1812. Like Mirbel and several other earlier workers in this field, Moldenhawer had his drawings from the microscope made for him by someone else (in this case by a lady friend), on the ground that more correct and trustworthy figures would be obtained if the observer employed other people's eyes and hands, and thus eliminated prejudice and preconceived opinion from the drawings.

CHEMISTRY.

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

TOXIC ACTION OF OIL PAINTS.—It has long been recognised that painters working with white lead paint are liable to suffer from headache and other specific symptoms, which have been attributed to lead poisoning. In order to ascertain whether any volatile emanations containing lead are given off by such paints, a series of experiments has been made by Professor E. C. Baly (*J. Soc. Chem. Ind.*, 1912, XXXI, 515).

In the preliminary tests brass tubes about a foot in length and an inch in diameter were coated on the inside with a paste of white lead and linseed oil, and a photograph was taken of the spectrum of the light transmitted through the tubes. A comparison of the result with the photograph of the spectrum of the light used proved that volatile emanations capable of absorbing light rays were emitted by the white lead paste, but not by pastes containing zinc white, or basic lead sulphate. In each case the tubes were gently heated to promote the separation of volatile substances.

Further experiments showed that the volatile compound was given off by white lead paints in appreciable quantities at the ordinary temperature, but no definite evidence of the presence of lead in the emanations could be obtained, even by heating four pounds of a stiff paste of white lead and linseed oil in a vacuum, and condensing the volatile products in a receiver cooled with liquid air.

Hence it appeared possible that the poisonous volatile substance might be due to the influence of the combined water in the white lead upon the linseed oil, whereas basic lead sulphate and zinc white, being anhydrous compounds, would not have such an action. The fact that a mixture of lead hydroxide and linseed oil had the characteristic odour of white lead paint soon after mixing, and gave off the emanation more readily than the latter, lent support to the view that the hydration of the lead carbonate was a main cause of the trouble. In other to react with mixture containing manganese dioxide, red lead and lead peroxide, the same volatile compound was also obtained at low temperatures (about 50° C.). It would, therefore, appear that to prevent the formation of the poisonous volatile substance, the pigment used with the linseed oil should contain neither a hydrated compound such as white lead nor an oxidising agent such as red lead. Driers acting by oxidation, such as manganese driers, are also objectionable for the same reason.

By raising the temperature to about 90° C. the poisonous substance was also emitted by pastes containing silica, lead sulphate and zinc white, but the absorption band in the spectrum did not appear at lower temperatures. The relative ease with which the pigments produced the volatile product could be expressed in the following ratios: Zinc white or basic lead sulphate, ten; white lead, one hundred and fifty; and lead hydroxide, two hundred and fifty.

The general conclusion was that the poisonous compound was given off by any paint containing an oxidising agent, and that the symptoms experienced by people living in a freshly-painted house must be attributed to this substance and not to specific lead poisoning.

Apparently it consists of an unsaturated aldehydic compound formed from the oil, and the means of preventing its formation are to replace white lead in the paint by basic lead sulphate or zinc white, and to have as little driers as possible in the mixture.

PREPARATION OF NITRATES FROM THE ATMOSPHERE. Mr. E. K. Scott, writing in the *Journ. Roy. Soc. Arts.* (1912, LX, 645), gives an outline of the present state of the industry of obtaining nitrogen from the air. With reference to the Birkeland-Eyde process, it is mentioned that the factories now possess installations of two hundred thousand horse power, which will be increased by fifty per cent. during the next four years. The towers employed to absorb the nitrogen peroxide produced have been very greatly reduced in size by the use of special packing material of earthenware instead of quartz fragments. The installations now at work or in process of building are capable of producing over two hundred and fifty thousand tons of calcium cyanamide (nitrolim) per year. The development of the industry in this country is checked by the want of a cheap source of electricity for the working process.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

THE ALKALINE IGNEOUS ROCKS OF AYRSHIRE. Recent researches by the writer have shewn that the intrusive igneous rocks of the Ayrshire Carboniferous, hitherto designated simply as "dolerites" on the geological maps, include a rich variety of petrographic types, some of which are new (*Geological Magazine*, February-March, 1912). They form a homogeneous suite which can be shewn to be connected with a volcanic episode at the close of the Carboniferous period, the remains of which form a small basin-shaped area of lavas in the district about Mauchline and Tarbolton.

The rocks of this petrographic province are, in general, of basic character, and are rich in alkalies and combined water. The retention of water in an alkali-rich magma has resulted in the rocks of the suite being characterised by analcite, a mineral whose claim to be regarded as an original constituent of igneous rocks has not long been admitted by the majority of petrologists. Many of the other minerals are also rich in alkalies. Soda-pyroxenes and amphiboles and nepheline are abundant in some of the rocks.

The intrusive rocks occur as stratiform sills, small lenticular masses, and as plugs and irregular intrusions in volcanic necks. Petrographically, they are classified as follows:

A.—Rocks with conspicuous analcite.

B.—Rocks with conspicuous nepheline.

C.—Rocks without conspicuous analcite or nepheline, but which may contain either as an accessory constituent.

The most abundant rocks of the first group, and of the whole suite, are the *teschenites*, gabbro-like rocks characterised by abundant analcite. Occasionally these assume ultrabasic modifications, and are to be described as *picrite*. Some of the picrite-teschenite masses shew the most extraordinary differentiation, many distinct types being found in the same igneous unit. Some of the analcite rocks are new to science, notably one called *lugarite*, from its type locality of Lugar. This rock contains nearly fifty per cent. of analcite and nepheline, the remaining half being composed of soda-pyroxenes, amphiboles, ilmenite, labradorite and apatite. Another rare variety is *analcite-syenite*, characterised by the combination of analcite with alkali felspar, and strictly analogous with the nepheline and leucite syenites. This rock is remarkable for its extreme freshness and for the abundance of aegirine, a soda-pyroxene rare in Scotland. A monchiquite, with huge phenocrysts of hornblende and biotite, completes the analcite-bearing suite, and has been described at length in a former note ("KNOWLEDGE," Vol. XXXIV, page 405). The nepheline-bearing rocks include *essexite*, *theralite*, hitherto unknown in Britain and remarkably fresh, and *kylite*, a new type which may be characterised as an olivine-rich, ultrafemic theralite or essexite, and so named from its abundance in the Kyle district of Ayrshire.

The rocks belonging to the third group may be called *alkali-dolerites*. They include numerous and varied doleritic types, characterised by purple soda-bearing pyroxene and accessory analcite or nepheline.

The lavas of the Mauchline basin consist mainly of very basic olivine-basalts, but certain of the types contain a good deal of original analcite, and may be designated *analcite-basanite*. Others contain fresh nepheline, and are true *nepheline basalts*. Recently, nepheline basalts fully as fresh and perfect as any of the Continental Tertiary examples have been found in the river Ayr, near Mauchline.

These rocks form a petrographic province whose boundaries are approximately those of the county of Ayr, although some part of it may be faulted down beneath the Firth of Clyde.

THE SEARCH FOR POTASH IN THE UNITED STATES.—Practically all the potash salts of mineral origin consumed in American industries are imported from Germany, which is the only country where potash mines are profitably worked. As the potash salts imported into the United States in 1910 cost nearly twelve million dollars, and this amount may be expected to increase rapidly in the future, the alert and efficient Geological Survey of that country set itself to discover whether the United States could not supply, at least partly, the needful potash, and thus break down the German monopoly which results in enhanced prices.

Among the available sources of mineral potash are the potash-rich igneous rocks which contain minerals such as leucite and orthoclase. The largest area of leucite-bearing rocks in the United States embraces the Leucite Hills of Sweetwater County, Wyoming. These have been investigated by Messrs. Schultz and Cross, and the results published in Bulletin 512 of the United States Geological Survey. A brief description of the leucite rocks is given, with an estimate of the amount of potash these rocks may be expected to yield when a suitable process for extraction has been discovered. The latter is now a problem for the technological chemist and the industrial engineer. Several reduction processes for extracting potash from igneous rocks have been patented; but, so far, none have proved commercially successful. The amount of potash stored in the lavas of the Leucite Hills is estimated at nearly two hundred million tons.

The mineral alunite, a sulphate of potash and alumina, is also used as a source of potash. An important deposit of this mineral, which promises to afford one source of the much-desired potash, has recently been discovered near Marysvale, Utah. It is described in Bulletin 511 of the United States Geological Survey. The alunite forms a banded vein cutting, at a steep inclination, the volcanic rocks (andesite and dacite) which form the greater part of the Tushar range. It is a fissure filling, not a replacement of the country rock, and has a typical banded or crusted structure. The vein has been proved for three thousand five hundred feet, and in that distance drops from an elevation of eleven thousand to about nine thousand nine hundred feet. This may be taken as good presumptive evidence of a corresponding continuity of the deposit in depth. At a conservative estimate this deposit would yield thirty thousand tons of potash (K_2O) for each hundred feet in depth. This is approximately one sixth to one-seventh of the total annual consumption of potash in the United States.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

GLOBULAR LIGHTNING.—An interesting account of this somewhat rare phenomenon has been furnished by Mr. S. Biggs, of Mazoe, South Rhodesia, who reports that in September, 1910, at about 9 p.m., he observed a ball of fire, the colour of an electric light, about one foot six inches by ten inches in size, and similar in shape to a Rugby football. The ball was luminous and transparent, but it cast no light beyond its own body. When first seen it was stationary over a road on Mr. Biggs' farm, and it remained in one position for about five minutes, during which time Mr. Biggs approached within three yards. The light then moved away in a zig-zag fashion at a rate of about six miles an hour, and finally entered a belt of trees, where it disappeared, leaving no trace whatever of its flight. No noise was heard, no trace of damage could be found, and no smell could be detected.

MICROSCOPY.

By F.R.M.S.

A BLUE SCREEN.—Take an unexposed process plate; fix it out in the dark with "hypo"; wash well. Now fix the gelatine film with formalin (ten per cent. or any convenient strength) as if it were a histological preparation; this may take several hours. Wash well and stain with aqueous solution of saureviolett (Grubler). Wash and dry. An excellent screen is thus produced, which will transmit only the blue and about half of the green. The intensity is modified by the completeness of the formalin fixation, but if this is omitted the results will be very unsatisfactory. The best plan is, therefore, to give plenty of time. I made my staining solution by adding water to a saturated solution of the dyestuff (which appears to be disulphonated dimethyldiethylpararosanilin) in seventy per cent. alcohol. The time of staining varies according to circumstances: it is, perhaps, best to leave the plate until no further staining action is observed.

E. W. Bowell.

MILES OF GREEN WATER.—Anyone who noticed the Regent's Canal in July must have been struck by the colour of the water. From the bridges it appeared of a dark green, quite unlike its usual aspect. From the tow-path the water was seen to be full of flocculent matter, diffused through it; but in corners and where the sluggish current was checked by barges or other obstructions the minute bodies collected and formed masses, floating on the surface like thick green grease or paint. The appearance was caused by the presence in astonishing quantities of a minute plant, one of the blue-green algae, an *Oscillatoria*; namely, *O. agardhii* Gom. This consists of extremely thin threads of various lengths, composed of cells, filled with pale green protoplasm. It is this which gives the colour, so noticeable owing to the immense number of the organisms. The cells have also in them several variously shaped, highly refractive bodies (see Figure 371), generally considered to be "gas vacuoles." Like other oscillatorias this one has a motion of its own, in addition to that afforded by the flow of water. It bends slightly backwards and forwards (oscillates—hence the name), and also progresses slowly through the water. It measures from four to five microns in diameter. In 1909 the same organism was present in the reservoir at the Welsh Harp, Hendon, in a similar manner. *Vide Journal of the Quekett Microscopical Club*, Series 2, Vol. XI, No. 67, page 115, *et seq.* I was told that the outbreak extended for more than twenty miles through the canal. There were present also considerable numbers of a minute spherical alga, with a very similar colour. It collects into irregularly-shaped bodies of different sizes, but never very large, each imbedded in a little mass of gelatinous matter. The composing units are about 3·5 μ in diameter; it is called *Mycrocystis*. A sample of the water collected had the remains of a number of Entomostraca floating on the surface, but I saw none alive. It was possible to identify the shells of *Bosmina*, and perhaps *Chydorus*, also that of *Cypris*, but the only living representative was the inevitable *Cyclops*, which seemed to be enjoying its usual health and activity.

Figure 371.
Oscillatoria agardhii Gom.

Rotifera were very numerous and lively, *Brachionus bakeri* and, I think, *B. urceolaris* and a *Philodina*, besides some smaller species were present. *Brachionus* was feeding on the oscillatoria, and it was interesting to watch it get the end of a long (comparatively) filament into its mouth, the end passing down to the mastax, which then worked vigorously at it; reminding one of a rabbit gradually drawing in and eating a grass stem. All of them showed the green of the alga in the mastax, and it was quite evident that the plant was not deleterious in its effect on them, as it is credited with being on fish. It is not easy to represent the refractive bodies in the oscillatoria; they change with the slightest alteration of focus, but Figure 371 shows—highly magnified—some filaments, and a few of the *Microcystis* drawn to the same scale.

Jas. Burton.

THE CUNEATE MARKINGS OF INSECT SCALES.—Readers of "Knowledge" are familiar with this subject through the articles and correspondence that have recently appeared in these columns, on the structure of "Podura" scales. The present writer has recently pursued some investigations into the nature of the markings of one of the Lepismidae (*Thermobia domestica*) the results of which have been communicated to the Royal Microscopical Society. A summary of the conclusions arrived at may be of some interest to those who have followed up the subject. In the first place it may be stated that the scales from *Thermobia domestica* are larger than "Podura" scales, and in many respects similar to those of nearly allied species, *viz.*:—*Lepisma saccharina*. The normal scale is somewhat ovate in shape and is traversed longitudinally by striae which are broken up at the margin of the scale into the familiar cuneate "exclamation" markings (see Figure 372). In the case of *Lepisma*

FIGURE 372.
Normal Scale of *Thermobia domestica* × 400.

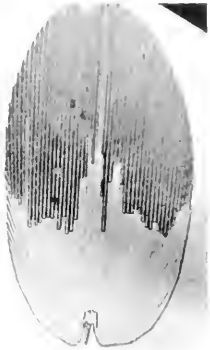


FIGURE 373.
Scale shewing both radial and longitudinal tubes × 400.

domestica the longitudinal striae were formerly supposed to consist of ribs united by a membrane, but there is no doubt whatever that they are really a series of hollow tubes, the juxtaposition of two neighbouring tube-walls producing the effect of a rib. This is best seen at the pedicle end of the scale, where the tubes are closed by rounded ends. Towards the pedicle, and radiating from the latter, signs of another oblique set of striae may be observed in the normal scale of *T. domestica.* These oblique striae were the apparent cause of the interrupted appearance of the longitudinal striae at the margin of the scale. That these oblique striae really cover the whole of one side of the scale was proved by mounting the latter in the gummy residue obtained by the distillation of commercial oil of turpentine. This method of mounting shows up the structure of both sides of the scale without optical interference of one set of markings with the other. The marginal cuneate or exclamation markings then disappear, and in some cases, by partial immersion of the scale in the mountant, both sets of striae may be clearly seen (see Figure 373). The so-called secondary markings are apparently caused by two factors—one, minute images formed in the interstices between the two sets of crossing striae, and two, images formed at the actual points of contact of the crossing tubes. By crossing two scales at an angle a complicated system of interrupted markings and secondary structure may be observed (see Figure 374).

In *T. domestica* the oblique striae are next the insect and the longitudinal ones outside. The scale is slightly concave-convex in shape, to fit to the curvature of the insect's body, this structure being most marked at the margin where the cuneate markings appear. The latter are mere optical appearances, and are produced by oblique illumination of the two sets of crossing striae or tubes. The oblique illumination is caused by the curvature of the marginal portion of the scale, and is independent of the source or manner of the illuminant to a great extent.

A careful examination of the interrupted markings with the one-tenth inch dry objective, the scales being in optical contact with the cover-glass, shewed that the markings changed their form with exceedingly slight alteration of the focusing. By slow downward focusing, four distinct stages in the evolution of the markings were observed, as represented by the accompanying drawings: 1. connected

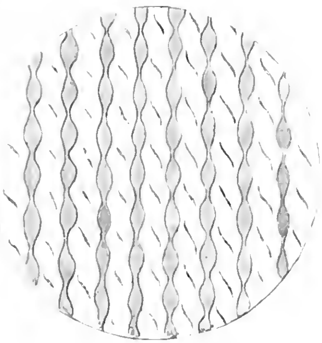


FIGURE 375.
First stage in the evolution of the scale markings—"connected beads."

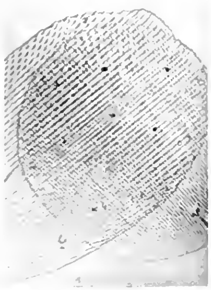


FIGURE 374.
The effect of crossing two scales.

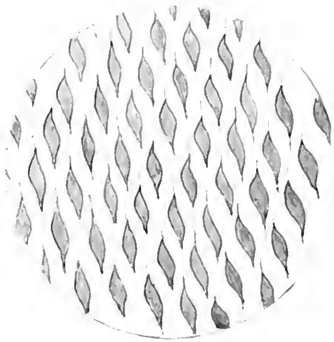


FIGURE 376.
Second stage—"separate elongated beads."

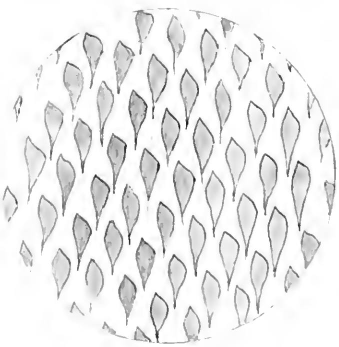


FIGURE 377.
Third stage—"exclamation or clubbed markings."

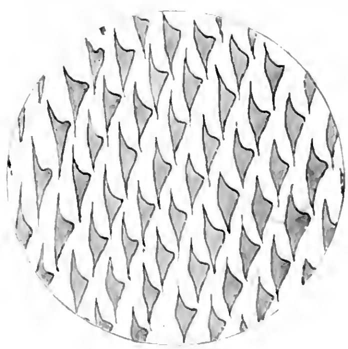


FIGURE 378.
Fourth stage—"cuneate or wedge-shaped markings."

beads (see Figure 375); 2, separate elongated beads (see Figure 376); 3, exclamation or clubbed markings (see Figure 377); and 4, cuneate or wedge-shaped markings (see Figure 378).

The scales of *T. domestica* appear to contain a highly-refractive oily substance in their composition, and when they are heated and subjected to mechanical pressure air-bubbles may be observed to move along the tubes. Some successful attempts were made to produce the structures of the scale on a large plan by crossing tubes of glass (filled with liquids) at various angles. As a result of these experiments a model, with two revolving sets of tubes in contact, was made, with which, by oblique illumination, cuneate markings were readily produced and photographed (see Figure 379).

JAMES STRACHAN.

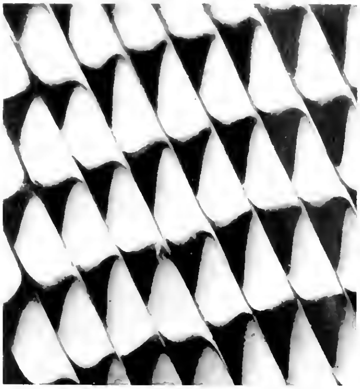


FIGURE 379.

Cuneate markings produced by oblique illumination of a model.

A NEW MICRO-TELESCOPE.—To all those who possess microscopes the knowledge that their instruments may be readily converted into telescopes of high power at small cost will be extremely interesting. The principle of this new invention, which is due to Mr. A. Cornell, of Tonbridge, Kent, resides in the combination with an ordinary mounted microscope of a telescopic objective and the "pin-hole." This combination produces an extremely sharp inverted image in the plane of the microscope stage, the inversion being corrected by the microscope element of the combination.

The attachment for converting a microscope into the telescope shown at Figures 380 and 381 consists of a draw-tube *a* carrying a suitable objective and containing a series of diaphragms for stopping down the light. These diaphragms are so proportioned that the amount of light is maintained through acute angles by concentration; as, for instance, when using an object glass of seven-inch focal length. These graduated diaphragms provide for extremely sharp definition. Although the focal angle is extreme, the *flatness* of field and the wide angle of same are extraordinary. With a telescopic objective of seven-inch focal length and a micro-objective of one-inch focal length a magnification of forty-five diameters is obtained. With such an arrangement Jupiter and four of his moons were observed with astonishing clearness during June. The best general results were, however, obtained with a one and a half inch micro-objective, which so far has given the brightest and most clearly defined image. With this objective the magnification was about twenty-seven diameters.

The attachment is made to fit into the diaphragm or Abbe illuminator rim or under-fitting *d* on the stage or sub-stage. By means of this combination when the telescope attachment is in place any degree of magnification from twenty to forty-eight diameters may be obtained by adjustment of the draw-tube and eyepiece to focus the micro-objective.

FIGURE 380.

The Micro-Telescope.

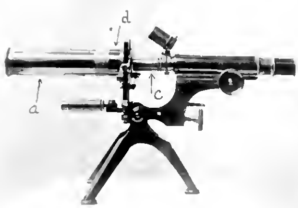


FIGURE 381.

The Micro-Telescope used horizontally.

The only alteration to the microscope which is necessary is to remove the stop screw or bar so as to allow the eyepiece to be lowered below the horizontal to admit of observing objects at an elevation. The ordinary reflector *e* may be removed, or simply turned out of the line of the tube of the attachment *a*. For astronomical purposes and to facilitate observation at high angles, such as the moon or stars at or near the zenith a reflector *b* is attached to the tube *a*. This reflector is ground optically correct for the purpose and is mounted upon a universal joint so as to be adjustable in all directions. By means of this reflector objects overhead or at high angles may be observed with the greatest ease and comfort. When the micro-telescope is employed for terrestrial observation, a tube *c* is employed to screen light from the gap between the stage and the micro-objective. This tube fits on to the micro-objective mount and is readily attached or removed.

The combination forms an exceedingly compact telescope of about fifteen inches in length, and the mechanical adjustments are available for focusing. To further facilitate observation, however, the tripod stand is secured to a special rotatable base mounted on a pedestal or tripod, the rotatable base being movable by means of suitable screw adjustments about vertical and horizontal axes, or two axes perpendicular to each other but inclined to the vertical or horizontal. Provision is thus made for keeping an object in the field of the telescope when it is being employed for astronomical purposes.

ROYAL MICROSCOPICAL SOCIETY. June 19th, 1912. H. G. Plimmer, Esq., F.R.S., President, in the Chair.—A paper by Lord Avebury was read, giving a short account of the development of pollen and of recent researches on fertilization which shows more and more complexity. He divided pollen into:—

(1) Aërial pollen carried by the wind. This was probably the original form, and was dry, spherical and smooth.

(2) Aerial pollen carried by insects, which as a rule was elliptical, but often spherical, in which case it was generally spiny.

(3) Sub-aqueous pollen, often elongated and filiform.

The forms of pollen are very various—barrel-shaped, square, facetted, dumb-bell shaped and many abnormal and peculiar types. He then alluded to the distribution of these forms in the different orders; in some of which the pollen is more or less uniform, while in others there are differences even in the same species.

The general colour of pollen is yellow, but it is sometimes orange, violet, blue, purple or white.

Perhaps the most remarkable case is that of the loosestrife (*Lythrum salicaria*) in which the pollen of the short stamens [illegible] yellow, while that of the [illegible] is bluish green. In some cases the [illegible] three, probably at some [illegible] of the outer wall.

A [illegible] the most common form of pollen is elliptical [illegible]. For this no explanation, he believed, [illegible] suggested. Such pollen was originally [illegible] assumed the elliptical three-ribbed [illegible] anthers and losing a certain amount [illegible] desiccation. Fairbairn in his "Useful Information [illegible] Engineers" describes how tubes give way [illegible]. They collapse at three equi-distant points, [illegible] a three-lobed form. Lord Avebury suggested [illegible] three-lobed form of most pollen was perhaps due to [illegible] cause, and did not present any advantage in itself. At the same time the extine was in many cases thinner in the furrows. This, he thought, was perhaps explainable as being due to inheritance. He suggested that the dumb-bell form was due to the fact of the furrows being shorter and deeper in the middle.

It was interesting to compare the form of the pollen when the order contained both anemophilous and entomophilous species. For instance, Compositae for the most part have spiny pollen and are entomophilous, but the Edelweiss and some allied species are anemophilous and smooth. The Rosaceae are almost all entomophilous, with elliptical pollen, but *Poterium* is anemophilous with spherical pollen. A good case is afforded by the Salicaceae; the willow is entomophilous, with elliptic three-ribbed pollen. The Poplars, on the contrary, are anemophilous with spherical pollen.

He then discussed the size of pollen, and referred to a long table which he thought afforded conclusive evidence that, though the size of the pollen did not depend entirely on the pistil, and the length, therefore, which the pollen tube had to traverse, still as a general rule, the longer the pistil the larger the pollen. The genus *Mirabilis* affords a very interesting illustration. It had been long ago noticed by Kolreuter that *M. jalapa* can be fertilized by the pollen of *M. longifolia*, but that *M. longifolia* cannot be fertilized by *M. jalapa*.

No explanation of this curious fact had, so far as he knew, hitherto been suggested. He submitted that it was probably due to the relative size of the pollen and length of the pistil—the pollen of *M. longifolia* being considerably larger than that of *M. jalapa*; so that the pollen tube of *M. longifolia* can reach the pistil of both species, while that of *M. jalapa*, though large enough for the pistil of its own species, is unable to reach those of *M. longifolia*. He concluded his memoir with a description of the pollen in the principal British orders.

A paper "On Some New Astrorhizidae and their Structure" was contributed by Messrs. E. Heron-Allen and Arthur Earland. Two new species of *Psammosphaera* and one of *Marsipella* were described from specimens dredged by Mr. Earland in the North Sea in connection with the work of the International North Sea Investigations (Scotland).

In *Psammosphaera rustica* the rhizopod constructs a polyhedral test of spicular fragments selected of suitable length and cemented side by side in a single layer, while in *Psammosphaera Bowmani* large flakes of mica are selected, and cemented together at the edges so as to form a polyhedral test. *Marsipella spiralis* constructs a straight tube of minute spicular fragments of approximately equal length, which are embedded, side by side, in a fine grey cement. The spicules are arranged in definite rows which run in a sinistral spiral round the tube.

The authors also dealt at some length with the minute structure of *Technitella legumen* Norman and *Marsipella cylindrica* Brady and described some hitherto unrecorded details of the construction of the tests in these species.

Dr. J. T. Gaskell communicated "A method of embedding tissues in Gelatin." The tissue is fixed in a formalin mixture; previous to embedding all formalin must be removed by washing in running water twelve to twenty-four hours. The gelatin is soaked for three to four minutes in cold water, then drained and melted, and the tissue is immersed in this for two to five hours in an incubator at 37° C. It is then cast in paper boxes in this gelatin and allowed to set at room temperature; when cool, it is put into a formalin vapour chamber to harden. The hardening is [illegible] satisfactory in a less period than three days, and may be continued indefinitely till the block is wanted.

Sections are cut by the freezing method, the block being pared down and attached to the stage of Aschoff's CO_2 freezing microtome by means of a drop of gum solution.

Sections can be obtained of any tissue 10μ thick and of most tissues hitherto tried 5μ sections are obtainable.

QUEKETT MICROSCOPICAL CLUB.—On June 25th, 1912, Mr. W. B. Stokes (the honorary secretary) read a paper on "Resolutions obtained with dark-ground illumination and their relation to the 'spectrum' theory." Serious students of microscopical images have long sought a crucial experiment which shall decide the claims of the two theories, those of Airy and Abbe, which have been put forward to explain them. The image obtained by dark-ground illumination offers the very example sought. If the Abbe spectrum theory is to be applied, it will be necessary for maximum resolution that a spectrum of the second order be included in the objective to cooperate with that of the first order, each spectrum just entering the objective on opposite sides. It was then shown, using the usual formula, that an objective of N.A. 1·0 and illuminator of N.A. 1·35 would resolve 58,750 lines per inch at λ 5080. It was found, however, in practice, that an objective of N.A. 0·86 with illuminator of N.A. 1·35 would resolve the 60,000 band of a Grayson ruling, and also the Cherryfield *Navicula rhomboides*, believed to have rows of perforations 60,000 to the inch. These results and others quoted would seem to show that we are justified in turning to the older (Airy) theory for guidance.

Mr. A. E. Conrady, F.R.A.S., said the formula quoted for resolving limit applied to a grating absolutely uniform in ruling and one which had also an infinite number of lines. When a grating has a limited number of lines it becomes easier to resolve. Grayson's thirty lines at sixty thousand is in this way subject to a discount of about three per cent. The coarsest line in a group of rulings will influence the resolution of that group.

Mr. R. W. H. Row, B.Sc., reported the occurrence, at Malden railway station, Surrey, and showed specimens, of a rare saw-fly, *Phyllotoma (aceris ?)*.

ORNITHOLOGY.

THE GREAT REED WARBLER.—Mr. E. C. Taylor writes from Yarmouth as follows:—"Your Ornithological readers may be interested to learn that the Great Reed (or Sedge) Warbler (*Acrocephalus turdoides*) was seen by me on Sunday last between Horning Ferry and Ranworth. I should consider that the bird being here at this time of the year makes it very probable that it has been breeding here.

I was on an entomological hunt by the side of a reed bed near a small "carr" when my attention was drawn by a bird of unusual size flying in and out of the reeds. It settled on the stem of a reed quite near me and I had a good view of it for quite thirty seconds and am certain of its identity."

"BRITISH BIRDS."—In the August number of *British Birds* there are as usual a number of very interesting notes. Mr. P. F. Bunyard records some of the earliest nests which he found in 1912. He thinks that May 1st for the Blackcap in Kent, and May 4th for the Lesser Whitethroat in Surrey may be new records. Mr. Jourdain, in an editorial note, however, gives April 28th for the latter bird on the authority of Mr. J. E. Harting, who states that an egg was found in Willesden on that date. Mr. Bunyard also found a Cuckoo's egg in Kent on May 6th, which is a fortnight earlier than any of his own previous records. A second specimen of the Isabelline Wheatear, Mr. Thomas Parkin records, has been shot in Sussex, which is apparently only the fourth specimen obtained in this country. It has been secured by Mr. W. H. Mullens, who has presented it to the Hastings Museum as an addition to the fine collection of local birds already given by him to that institution.

PHOTOGRAPHY.

By EDGAR SENIOR.

PHOTO-MICROGRAPHY WITH MEDIUM POWERS.—In dealing with the subject of low power photo-micrography in the June number of "KNOWLEDGE" we explained that the size of the images produced was the result of considerable camera extension "one hundred and sixty-three centimetres," and in the last issue of the journal it was shown how the magnification could be still further augmented, by the use of an eyepiece "ocular" although at the expense of very considerable restriction of the field. If the two illustrations, photo - micrographs of the proboscis of a blow fly, one magnified eighty diameters and the other "a portion" three hundred and twenty diameters, be carefully examined, we fail to find any difference in the amount of detail present in either. The question, therefore, naturally arises as to what is the use of this extra and great amplification; what does it do? and is it necessary or desirable? To answer this question several things have to be taken into consideration, such as the resolving power of the objective, and the magnification that may be necessary in order that the eye may be able to clearly discern the structure resolved. As the primary use of a microscope is to enable the observer to see distinctly the minutest details in the image of the object under observation, a degree of enlargement that will ensure this would appear to be all that is necessary, unless from individual requirements or photographic purposes it be desired to go beyond it. In order to arrive at the conditions requisite to get the most out of our instrument, we must first of all consider the objective, with regard to its ability to resolve fine structure. Now it is well known that the resolving power of any lens depends upon its aperture, and that of the one inch objective employed in photographing the images of the proboscis was found to be ·2 N.A., and this theoretically should possess a resolving power for the brightest part of the spectrum visually of nineteen thousand. In other words, the lens should be able to separate lines or structures as close together as the one nineteen-thousandth of an inch. It only remains then to magnify the image sufficiently that the eye may be able to see the details readily when viewed under proper conditions. It is generally considered that the normal eye is able to distinguish lines as close together as the one two hundred and fiftieth of an inch when viewed at a distance of ten inches from it. So that in order to take full advantage of the resolving power of our lens we should have to enlarge the image seventy-six times, in this case, to fulfil the required conditions. As the magnification was eighty diameters nothing further should be gained by increasing it, unless, of course, it were found not sufficient in individual cases. It has been stated that the limit for best definition is reached by employing as the degree of magnification "in diameters," the value obtained by multiplying the N.A. of the objective by four hundred. So that in the above case in which the N.A. = ·2 we should get 400 × ·2 = 80 diameters, and any further increase beyond this would result in an inferior image. In considering, then, the question of photo-micrography with medium powers, it is not so much the increase in the initial magnifying power of the objective that concerns us, as the gain due to their larger aperture. As an example we may take the illustration to this article, which was photographed with a Zeiss sixteen millimetre apochromat with a four-inch projection ocular. As far as size of image is concerned, this could have been obtained by using a higher eyepiece with the lower power, but the sixteen millimetre has an aperture of ·3 N.A. as against ·2 N.A. in the former case, which means that the resolving power is half as much again with the sixteen millimetre lens compared with that of the twenty-four millimetre one. We thus see that the aperture is the all-important consideration; that mere magnification beyond the degree necessary for observation becomes useless, but as the initial size of the image increases the higher the power of the objective, a lower eyepiece can be employed with advantage. The illustration (Figure 382), taken with a Zeiss sixteen millimetre apochromatic objective and a four-inch projection ocular, was magnified four hundred diameters. The negative was made on an Imperial N. F. plate of a speed of two hundred and twenty-five H. and D. An exposure of ten seconds was given, using a deep orange screen, the specimen being stained blue. The image was developed as before with pyro and soda.

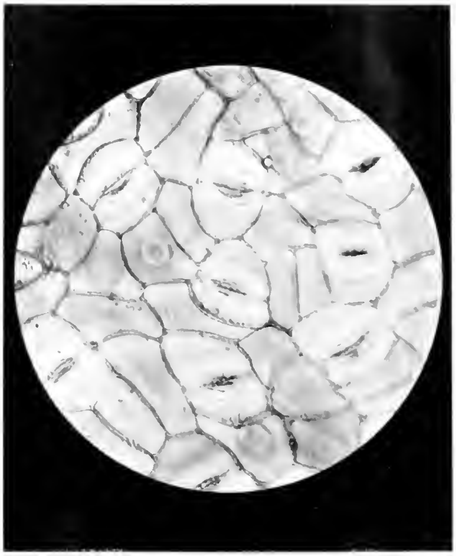


FIGURE 382.

Stomata in Cuticle of Mistletoe × 200 diameters.

Photographed with a Zeiss 16 mm. Apochromatic Objective and a four-inch Projection Ocular.

EXPOSURE TABLE FOR SEPTEMBER.—The calculations are made with the actinograph for plates of speed two hundred H. and D., the subject a near one, the lens aperture F. 16.

Day of the Month	Condition of the Light	Time of Day. 10 a m and 2 p m	9 a m and 3 p m	7 a m. & 5 p m.
Sept 1st	Bright	12 sec	14 sec	28 sec
,, ,,	Dull	24 ,,	28 ,,	57 ,,
Sept 15th	Bright	13 sec	15 sec	35 sec
,, ,,	Dull	27 ,,	3 ,,	7 ,,
Sept 30th	Bright	15 sec	19 sec	63 sec
,, ,,	Dull	3 ,,	39 ,,	1′26 ,,

Remarks If the subject be a general open landscape, take half the exposures given here.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

FORMATION OF HABITS.—One of the most interesting kinds of modern work in natural history is the study of habit-forming. Mr. Asa A. Schaeffer has been recently experimenting with frogs in this connection. Individuals of three different species, *Rana clamata*, *R. sylvatica* and *R. virescens* learned to avoid disagreeable objects, such as hairy caterpillars, in from four to seven trials, and the habits persisted for at least ten days. A *Rana clamata* learned in two trials to avoid earthworms treated with chemicals, but the "habit" persisted [illegible] for only a short time. When the hairy caterpillars were avoided, active muscular rejection of the caterpillar accompanied each trial; but in the trials of the chemically treated earthworms, no rejection, nor any muscular action other than active swallowing of the food, was observed. "The latter habit was formed entirely within nervous tissue." "The rapid formation of habits and the peculiar process of elimination observed while the habits were formed, indicate intelligence of a relatively high order."

HEARING IN FISHES.—Using the term "sounds" to include any vibrations of the water, it may be said that sounds affect fishes through three sets of sense-organs—the skin, the lateral line organs, and the ears. Professor G. H. Parker has made some interesting experiments and observations, particularly as to the effects of explosive sounds, such as those produced by motor boats and guns.

It has been shown within recent years that a fish can feel sounds through its skin in much the same way as a man can feel the vibrations of a musical instrument when his hand is in contact with it. It has also been shown that some fishes are aware by means of their lateral-line system of relatively low vibrations, such as trembling movements of the water. Thirdly, Professor Parker has convinced himself that the internal ear is also an organ of hearing. This may seem a gratuitous thing to prove, but only to those who are unaware that there are many ears which are not hearing ears. The ears of fishes have to do with the adjustment of bodily motions and equilibrium.

"The sounds produced by motor boats are extremely faint under water, and have little influence on the movements and feeding of fishes. Such influence as they do have is temporary, and very much restricted in local extent. Single explosive sounds, like the report of a gun, may startle fishes and cause them to cease feeding, but these responses are also temporary and local. Although most sounds are repellent to fishes, some may serve as lures to particular species." Fishes like the Drumfish and the "Squeteague" produce noises which are, without much doubt, concerned with bringing the sexes together at the breeding season.

LOCOMOTION OF SEA-URCHIN.—Some thirty years ago Romanes and Ewart pointed out that a sea-urchin uses its lantern in progression out of water, and gave an account of the manner in which the lantern acts. But this seems to have been lost sight of. In 1910, Miss Abel, a student attending one of the nature study classes at Millport Marine Station, noticed that the sea-urchin given her to observe seemed to move by lurches occurring at intervals, and that just prior to each lurch the whole urchin rose up slightly from the surface of the table. This observation was the starting-point of a careful investigation by Dr. J. F. Gemmill into the locomotor functions of Aristotle's lantern.

"When travelling actively (out of water) the urchin raises itself from time to time on the tips of its teeth in preparation for a forward "step." The step is then accomplished by means of (a) strong pushing or poling on the part of the lantern; (b) similar but usually weaker action on the part of the spines; (c) the influence of gravity acting at a certain stage. After each "step" the lantern is retracted and swings forward, so that the teeth come into position for initiating a new "step."

Under water the lantern is not needed for ordinary locomotion, particularly over more or less horizontal surfaces. The tube-feet and the spines are the effective agents. But it will help if the urchins are loaded, or travelling up a slope on certain surfaces, or only partially immersed, or mounting rapidly up a vertical surface.

"The locomotor action of the lantern in urchins is a particular manifestation of a rhythmic functional activity which can also subserve feeding (no doubt the chief function), boring, and forced respiration. In addition it possibly aids the swallowing of food, the evacuation of faeces, and the maintenance of physiological turgescence in various internal cavities." Filling of the gills takes place during retraction of the lantern and emptying during protrusion.

MECHANISM OF RESPIRATION IN INSECTS.—When we watch a drone-fly, for instance, seated in the sunshine in the middle of a dandelion inflorescence, we notice panting movements of the abdomen,—the expiratory movements; for recent research, like that of Johann Regen's, fully confirms the old conclusion of Rathke and others—that expiration in insects is the active process and is mainly due to the contraction of abdominal muscles. The abdomen expands again because of its elasticity and the air enters the tracheae passively. It is an interesting instance of analogy that in insects and in birds we should find the same peculiarity of active expiration and passive inspiration,—so different from what we are familiar with in our own body

COLOUR CHANGE IN SALAMANDER.—It has been proved by Kammerer and others that the Spotted Salamander (*Salamandra maculosa*) becomes almost black when the soil of its vivarium is dark and relatively dry. Two things happen: the yellow areas become gradually smaller, retreating towards the centre until they disappear; and the dark areas become darker. Experiments following the ordinary method of exclusion, *e.g.*, using a black-paper ground with normal humidity, show that the shrinkage of the yellow spots is affected by the colour of the ground, and the darkening by increasing drought. Alois Gaisch relates in corroboration of Kammerer's experiments that he put a salamander into a vivarium with black peaty soil which remained moist, and found it almost unrecognisable after three months. He gave it a good bath, but it remained very dark. The yellow spots had become much smaller and there were many black dots about their margins. Microscopic examination showed that black pigment had abundantly invaded the yellow areas. An interesting fact, noted by Gaisch, is that two other salamanders put in about the same time showed no change of colour, which seems to show that there are differences in individual susceptibility, perhaps in age-susceptibility.

AMPHIBIANS OF THE GREAT COAL SWAMPS.—The ancient forest-swamps of the Coal Era have meant much to man, and their exploration has a unique interest. Mr. W. D. Matthew, of the American Museum of Natural History has been telling us lately about *Eryops*, a primitive Amphibian which lived about the close of the Carboniferous Period—"five times as old as *Eohippus*, a hundred times as old as the mammoth or mastodon or the earliest known remains of man." It was "a sort of gigantic tadpole or mud puppy, with wide flat head, no neck, a thick heavy body, short legs and paddle-like feet and a heavy flattened tail." Heavy and clumsy, small-brained and slow, it was near the top of the genealogical tree in its day! "The giant dragon fly that darted over the head of the slow-crawling *Eryops* might seem, except in size, a far superior type of being, a far more promising candidate for the position of ancestor to the intelligent life which was to appear in the dim future." But it had reached the limit of great organisational change, while "the amphibian was but beginning the adaptation of the vertebrate structure to a terrestrial life." Perhaps the possession of an internal instead of an external skeleton was, as Professor Shaler suggested, an important feature in giving free play to evolutionary potency which lay concealed in these unpromising amphibians of the carboniferous swamps.

HOW DOES A YOUNG BIRD BREAK THE EGG-SHELL?—The answer that rises to the lips is "By means of its egg-tooth." But the bill and its egg-tooth are only the instruments, what about the musculature? Franz Keibel has inquired into this in the case of the chick and the duckling. He finds that it is the musculus complexus that is actively concerned, and that it is very markedly hypertrophied for some time before hatching. On the tenth day after hatching it shows no peculiarity.

SENSE TRAINING.

By JOHN B. HUBER, A.M., M.D.

To one ambitious of leading the scientific life, sense training is from the beginning most essential. "Seeing is believing," but the belief thus founded may not be rational. Seeing, reviewed and if necessary revised by the reasoning faculty, will then be soundly based. Only from such process can facts be born—facts, the only building material with which science can work. The senses are by no means a sure guide; the very best they can do is to appreciate phenomena: that is, appearances. The stick appears broken in the pail of water: reason assures that it is not. Using a bright spoon for a mirror, one appears variously, as he holds the spoon inside or outside, or up and down, or sideways; but it is to be hoped one does not look any of those ways in reality. Cross the middle over the index finger: roll their tops over a bread pellet in the palm of the other hand, and the sense of touch will convey the impression of two pellets; but reason corrects the impression, and convinces us there is but one. Reason must ever bring judgment, memory and experience to bear upon the perceptions which the senses convey to the cerebrum; by these means reason must constantly be rectifying false sense.

It is amazing how frequently the imagination plays fast and loose with the sense functions: delusions, illusions and hallucinations being the result. Le Bon, in his fascinating book "The Crowd, A Study of the Popular Mind," tells of a crew shipwrecked upon a raft, who kept eagerly scanning the horizon for a sail. After some days of watching one of these poor men, his psychism perturbed by his sufferings, being obsessed through desiring to see a rescuing ship, unquestionably saw something; and so desperate was the hope of his companions, that one and all agreed with him that the thing he pointed out was a vessel which could rescue them. When they came upon it, however, they found it but a tree which had evidently been uprooted and had gone adrift in an equatorial storm. Tuke, in his admirable book "The Influence of the Mind on the Body," relates how a boy who had on an afternoon seen a hanging, which had naturally much affected him, took a stroll along a country road in the evening of that dreadful day. He presently saw projected against the moon-lit sky the gibbet of the afternoon, and the criminal suspended from it. He ran home dreadfully frightened, to find that a cord dangling over the brim of his hat had by his overwrought imagination been metamorphosed into the aërial gallows.

Every reader will recall how he has in like manner been tricked by his senses. Hundreds of instances might be cited of delusions entertained by the unscientific, the unsophisticated, the highly emotional; people in whom such aberrations are not without excuse. We who pride ourselves upon our attainments in science are so prone to consider such delusions the exclusive property of geniuses, spiritualists, theosophists and other people whose imaginations tend to work overtime, that we feel distinctly humiliated to learn how men even eminent in science have been the victims of psychic perturbations: as for instance, when the telephone was invented, a lecturer who was giving a public exhibition of the apparatus clearly and repeatedly heard the notes of a trumpet which he had arranged to be played at the other end. He declared that he heard; nor need the record be doubted. Yet none of his audience could hear the trumpet; and for the all-sufficient reason that the trumpeter had made a mistake in the day, and was not in his place at all.

A very modern instance of "illusion caused by a species of auto-suggestion based on preconcerted ideas," is furnished by the episode of the N-rays, which all competent men now agree never had any existence at all. Professor Blondlot believed (in good faith, of course), that he discovered these rays at Nancy in 1903. He described them before the French Academy of Sciences, which body gave him a gold medal for his discovery.

Up to 1906, there were published one hundred and seventy-six original papers concerning these rays. Blondlot's observations were in turn confirmed by such well-known physicists as Charpentier and Becquerel. The N rays were considered to be given off by almost all substances when in a state of strain; a tempered steel bar, Nerust lamp, and even a human nerve and muscle would emit them. The rather fanciful suggestion was advanced that if a certain radiation were given off by our bodies, according to their degree of activity, our thoughts might possibly be photographed: "thoughts being only brain rays." (Of course, the work within the last year of Drs. Kilner and Fielkin in London, as to the photographing of the "atmosphere" or the "aura" which the human body is considered to exhale, springs at once to mind.[1]

The N-rays, stated French investigators, could be reduced or removed by anaesthetics; a tempered steel bar, for that matter, could be chloroformed into quiescence. Following upon this the invitation came naturally enough to men of science "to revise some of our notions on the difference between the organic and the inorganic." The N-rays were held to be even more wonderful than the X-rays or radium. Oddly enough, however, the N rays did not, like the X rays, affect either the spectroscope or photographic plates. Admittedly they were rather baffling and elusive, at least to those inexperienced in detecting them; but they had one physical effect upon which experimenters relied—their power to intensify a light. A marked increase of luminosity was considered to be perceptible when an N-ray was directed upon a spark; or if a bar of tempered steel were held near a clock in a dark room, it was supposed to be possible to read the time.

As the months rolled by Blondlot's experiments were confirmed, and were even extended outside France. Yet many scientific men utterly failed from the first to observe any of the phenomena described. English and German investigators became particularly sceptical; and rather absurdly a dispute arose which, by the law of the crescendo in psychology, accrued progressively as to bitterness; compliments increased in warmth as they lost in polish. Things became quite akin to that immortal "Row upon the Stanislaus." Two camps were formed—the Latin and the Teutonic. The French imputed racial prejudice and animosity to their foreign critics. It was suggested that the rays could be distinguished only by the more sensitive and finer fibred brain of the Latin; whilst what, *sacre bleu!* could be expected of the fog-muddled British brain, or of the beer-befuddled German psychism! The matter in dispute threatened to place itself beyond the bounds of any reasonable demonstration. Presently, however, the coolest French scientific men gradually came to suspect that if no results could really be obtained in England or Germany, the explanation of the French experiments must be subjective and psychological rather than objective and physical.

Finally, the *Revue Scientifique* settled the question in a very simple way. It was proposed that several boxes of exactly similar appearance, some containing pieces of lead, others of tempered steel, should be sealed; and Blondlot or his assistants were to decide which of the boxes contained the active material. Blondlot refused this test, saying that "the phenomena were far too delicate for such a trial"; and he left "everyone to his own opinion on the N-rays, either from his own experiments, or from his confidence in others." Thus was the dispute transferred from the realm of fact to that of opinion, experimentation ceased, and so far as science is concerned the incident was closed.

Such incidents as these are rather humiliating to the scientific temperament, which, nowadays, is just a trifle inclined to self satisfaction. Fortunately, they are extremely rare. Science is knowing; good science is ever certainty grounded upon demonstration. To this end the pre-requisite is the trained senses. Science's votaries, moreover, if they are to serve her well, must ever be free of auto-suggestions and haphazard conjectures incapable of verification.

FURTHER REMARKS ON THE TRUE STRUCTURE OF THE DIATOM VALVE.

By F. I. SMITH.

A CHANCE discovery, often the only one fortunate chance of a lifetime, has enabled the writer to push our definite knowledge of diatom structure still some steps onward from the point reached in his last article. Trusting that the results here shown will prove of both interest and value, he now begs to lay them before the readers of "KNOWLEDGE." He wishes also that this article should serve a twofold purpose: the second as illustrating what can be done by high-power work in photomicrography with cheap lenses. The illustrations for the last article were all produced by expensive apochromatic objectives. For the present one, only the ordinary achromatics were used. Most of the negatives reproduced here were taken with his own lenses—a dry one-sixth inch of 0·85 N.A. (only one with this), and an oil-immersion one-twelfth-inch of 1·30 N.A., both by Swift & Son. For the others he is indebted to the firm of Mr. Charles Baker, of Holborn, who kindly placed one of their one-twelfth inch oil-immersions of the same aperture at his disposal. The figures may be allowed to speak for themselves, though it may be pointed out that the apochromatic used on the previous occasion had an aperture of 1·40 N.A. and was besides the finest of its class: while the achromatics used to illustrate the present article were limited each to 1·30. To say nothing of apochromatism, this difference upon many objects may not mean much. When, however, optically separating closely connected structure the extra ten points tell.

FIGURE 583.

Pleurosigma formosum, showing torn fibrils projecting over the empty space where part of the under layer has sunk to the slip. Magnified one thousand six hundred diameters.

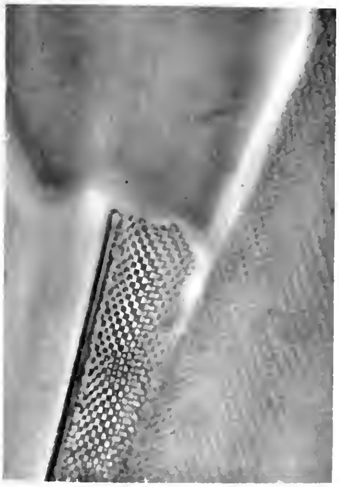


FIGURE 584.

The under layer of the same valve, showing where the sunken part has broken off.

One thinks it necessary for the benefit of others to call attention to these matters. It has been, indeed, the habit of some writers to throw cold water upon the employment of the ordinary lenses for photography in high power work. In the language of one: "That while with low powers, when used in conjunction with suitable screens, excellent pictures can be produced . . . with high powers this is not the case, and those who desire to obtain the very finest results possible by the aid of photography, should certainly obtain the services of the apochromat rather than of its cheaper rival." Indeed, in an annual of microscopy, the same writer has produced two plates, to show by contrast the difference of appearance between the same object, when photographed by the apochromatic and the ordinary achromatic objectives. Yet he admits in his last book that it is often difficult to tell at first the difference visually between the two, as the present cheap lenses are made.

Now this present writer will admit that after reading the words, "the very finest results possible," it was with fear and trembling he approached the task of high power work with the cheaper rival. Yet after all, there is no magic required in photomicrography. He has always maintained that the common objective will produce as good an image in a photograph as it does visually. The image upon the screen, whether good or bad, is really the thing. After, it is the same process as in ordinary photography. Of course, one is aware that in many lenses there is a want of coincidence between the chemical and the visual foci. The use of orthochromatic plates in nearly every instance will correct this discrepancy, and the same kind of plate, used with a suitable screen, will correct the remainder. An ordinary achromatic with a red correction will work upon any kind of plate.

An eminent authority in microscopy confirms this opinion. Mr. E. M. Nelson, in one

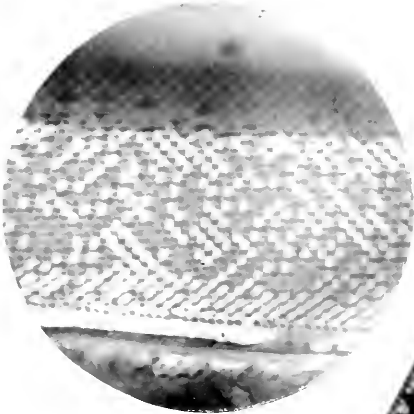


FIGURE 385. *P. formosum*, showing patches of little white discs amongst the fibrils, × 2000.

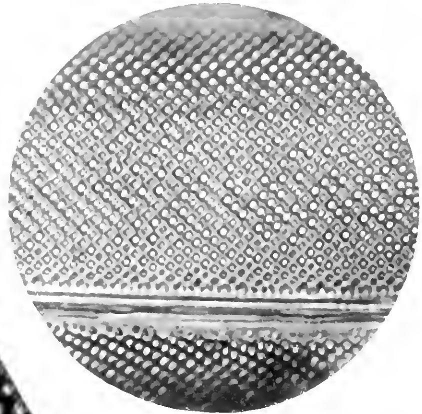


FIGURE 386. The layer underneath, showing the cause of the patches above.

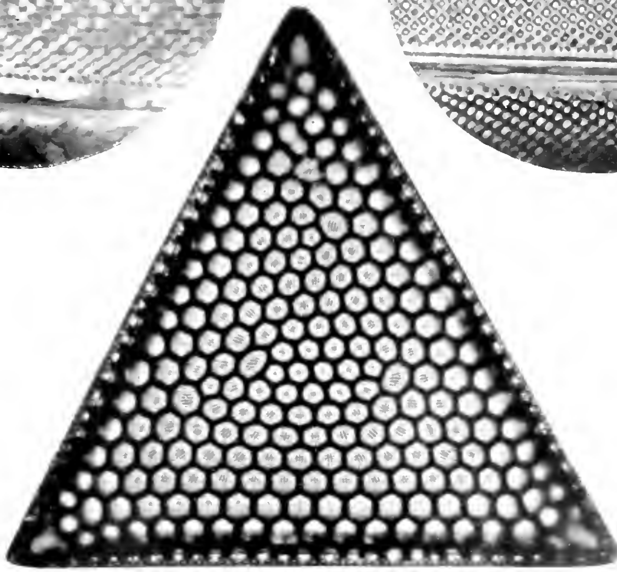


FIGURE 387. *Triceratium favus*, side view. Objective used, Swift & Son's one-sixth inch, dry of 0·85 N.A., orthochromatic plate, no screen, magnification six hundred diameters, exposure by lamplight ten minutes.

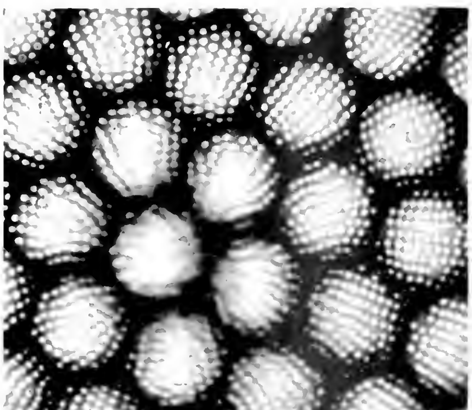


FIGURE 388. Part of the same valve × 2500. Objective used, Swift & Son's oil immersion one-twelfth inch of 1·30 N.A.

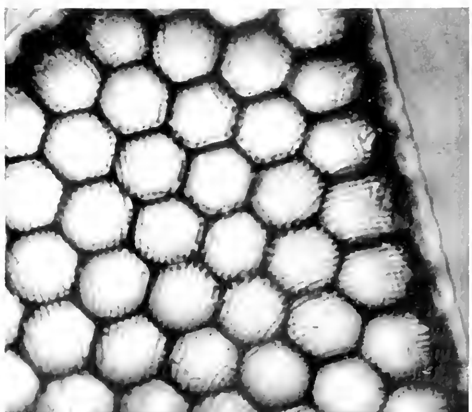


FIGURE 389. *T. favus* from another valve, showing torn structure. Magnified one thousand five hundred diameters.

of his addresses as president of the Quekett Club, when speaking of screens used in connection with objectives, says: "They are of special service with cheap lenses (*i.e.*, semi-apochromats), because they remove the secondary spectrum, making the lens as efficient as an apochromat. So remarkably is this the case that with equal apertures it is impossible to say whether the objective on the nose-piece is an expensive apochromat or a cheap semi-apochromat. In photomicrography not only are the preceding remarks applicable, but also colours difficult to photograph are rendered neutral."

The photomicrographs obtained with the Swift oil immersion to illustrate the present article, were taken in conjunction with a yellow screen upon colour correct plates; those with the Baker objective upon ordinary plates, some without a screen and the others in connection with a pot green screen, cutting off the red. This screen undoubtedly increases the resolving power of the lens, besides producing a beautiful image. In photographing with lamp-light, however, it has the disadvantage that the exposure must be prolonged for at least fifteen times beyond that required without a screen. The average exposures with no screen, ranged from ten to fifteen minutes, with a yellow screen, from a quarter to half-an-hour, and with the green screen, three hours. Unfortunately this is not the worst: the chances are that after the three hours one will find the focus shifted, and the image useless. With a camera upon a common kitchen table, over which each end projects at least a foot; with the table upon a floor with wooden joists; when it is sought to use a magnification of 2750 diameters the conditions are not conducive to too much stability.

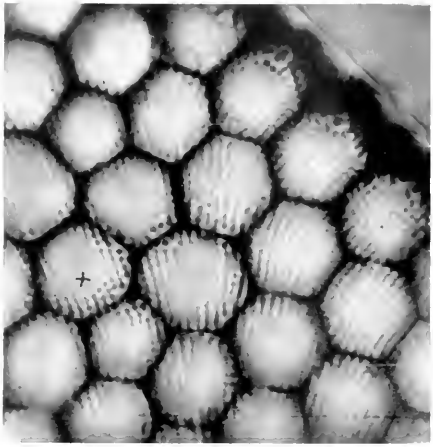


Figure 390. *T. favus*, same valve, to illustrate the forming of pseudo-hexagons, black dot. Magnified two thousand five hundred diameters.

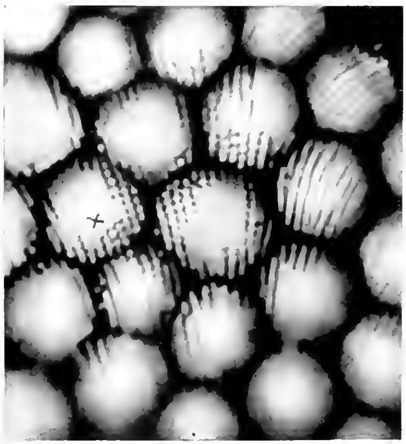


Figure 391. *T. favus*, from the same spot, to show the white dot. Magnification the same.

The first part of the present article, now that we are come to the subject, is rather an attempt at meeting objections, of further amplications of the last, than of raising new points. As to the first there is always a doubt in many minds as to the reality of structure when one is said to be superposed upon another: Mr. F. J. W. Plaskitt, to wit, who speaks of the fibrils in *Pleurosigma* as being kaleidoscopic. One wishes he had given the chance to reply to his strictures; yet, like the small boy in *Punch*, who chalked up "No Popery," and then ran away, he finds it more prudent to retire from the contest. Figure 383 of this article, however, should settle the point. In a broken valve of *Pleurosigma formosum* the fibrils are seen projecting forward into space, the corresponding part underneath being wanting, or rather having sunk to the bottom against the slip. The fracture where it has broken off is shown in Figure 384, taken at a lower focus.

In Figures 3 and 3A of the first article, there is shown in one the normal appearance of the outer side of the valve and, in the other, the second layer immediately underneath. Figure 9 of the same article shows the fibrils causing the appearance naked, as it were; but the letterpress assigns no reason beyond saying that the valve had been acted upon in some way. This lack of information, one thinks, can now be supplied in the Figures 385 and 386 of the present article. Of course, it is understood that the description can only apply to a valve mounted dry; when mounted in a medium all such fine distinctions are obliterated. In Figure 385 the fibrils are seen placed lengthways upon the valve, but at intervals there are collections of bright discs of light entangled amongst the meshes. Underneath, in Figure 386, is found the cause. The under surface is occupied by an apparent sieve-like structure; but instead of being regular in size, many are much larger, and in the grouping correspond to the focal points of light in Figure 385. The explanation seems to be this. Only the larger apertures underneath appear to be capable of acting as lenses of long enough focus to form an image in the grating above. The others stop short, either form no image or weaker ones represented by the apparent rings. In only a few instances, however, are these irregularities of structure seen, and not often is there an appearance of rings, even when not otherwise filled. The spread slide from which the photographs were taken contains hundreds of forms, but only in some half-dozen are those variations apparent. The rest, on the outer side, look as in Figure 387, referred to above. Yet the few exceptions supply the key to the structure of the *Pleurosigma* valve.

The loan of a spread slide by a friend has supplied the writer with the materials for the greater part of the rest of his article, *Triceratium favus* there being one of the leading features; upon one of the specimens, and others after that, he stumbled upon what he thinks is a surprising discovery. The surprise also is that no one had ever made it before. He has started enquiries and satisfied himself that the knowledge up to now remained as his own sole possession. Yet no other genus of diatoms has been so much written about. *Triceratium*, like other families of distinction, possesses a history, and was one of the first of the kind to find a historian. It was also the earliest upon which was discovered what is now known as secondary structure.

The genesis of this family is first recorded by Mr. Brightwell, F.L.S., in the July number of *The Quarterly Journal of Microscopical Science* for 1853, the title, "On the Genus *Triceratium*, with Description and Figures of the Species." In the beginning of the article he says: "The genus *Triceratium*, with several other species, was established by Ehrenberg in a memoir communicated by him to the Berlin Academy in 1839-40. He founded it upon two species, *T. favus* and *T. striolatum*, the former of which is generally taken as the type of the genus." A plate accompanies the article. There is no mention of secondary structure by Mr. Brightwell, only of "larger or minute cellules": what is now known as the framework of hexagons. A second article from the same pen appears in the July number of the same journal for 1856, increasing the number of species, and is accompanied by another plate.

The next article in the same journal for July, 1858, is by Dr. Wallich, of the Belgian army, on: "*Triceratium* and some near allied forms," accompanied by a plate. There for the first time we find a hint, and a very small drawing of secondary structure in this diatom. There is also an allusion, somewhat obscure, to the possibility of discovering similar structure in other genera of diatoms. Speaking of *T. fimbriatum* (only a variation of *T. favus*), Dr. Wallich says: "Each hexagon in the St. Helen form being, not merely a simple depression dependent upon the mode in which the siliceous element is secreted by the inner cell membrane on its inner surface, but a deep hollow cell, with perpendicular sides of

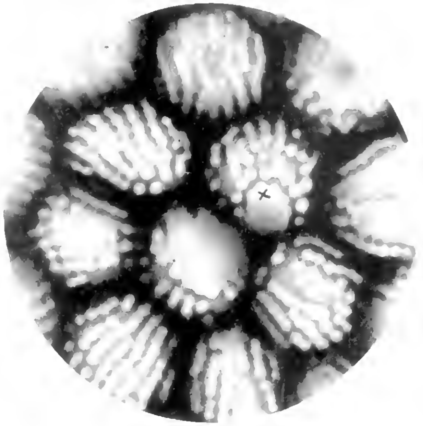


FIGURE 392. *T. favus*, from the centre of the same valve. Magnification direct—three thousand diameters.

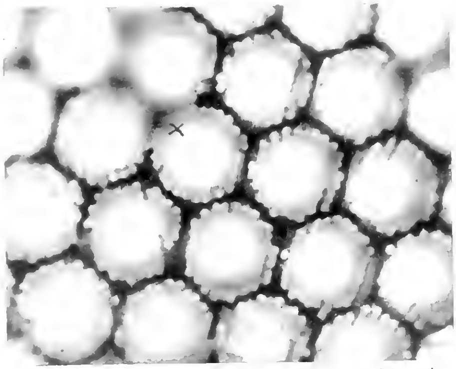


FIGURE 393. *T. favus*, from fragment of another valve, showing nearly all the fibrils torn away, and the covering over the hexagons wanting, where marked. Magnified two thousand diameters.

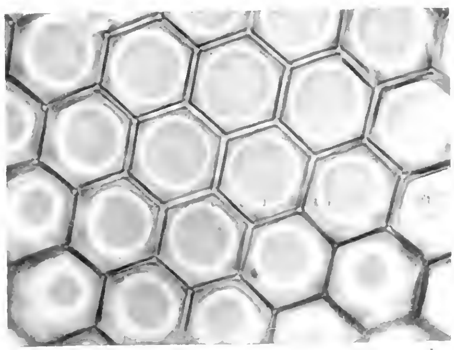


FIGURE 394. The same, showing the hexagons underneath sound. Magnification the same.

sufficient depth to be readily measured, when seen in fragments and in profile . . . . The floor of the cell is also minutely punctate, being arranged in quincunx. The minute puncta require careful illumination and a power of four hundred diameters to render them quite distinct."

We next come to 1872. In a brief communication to *The Lens*, a short-lived American microscopical journal, Dr. Woodward, the eminent American microscopist, says of the "Double Markings of *Triceratium*," of which photographs are enclosed: "When the rows of dots seen in the broken frustule are examined by immersion objectives of the highest power and best quality, they appear with white light as garnet-red beads on a greenish ground, approximating in size and appearance to the beads of *Pleurosigma angulatum*. . . . . The comparative thickness of the frustule, and the marginal walls of the areolae, interfere considerably with clear definition with these high powers; still, I think an impartial examination of the figures will dispel all doubts as to the real nature of the markings."

The above passage is interesting and instructive in even more senses than Dr. Woodward intended at the time of writing. He speaks of immersion objectives of the highest power and quality as being employed to resolve the markings. Oil immersions were not known then, but his own favourite glass was a one-sixteenth inch water immersion of Powell & Lealand with a N.A. of about 1·21. Figure 387 of *T. favus* was taken with a dry, one-sixth inch of 0·85 N.A., and speaks eloquently of what we owe to the new Jena optical glass in producing cheap lenses. This, however, in passing.

That the markings on the floor of *T. favus* and allied species occupied a lower level than the walls of the hexagons, was the commonly received opinion. Indeed, it appears to be the common opinion now. Messrs. Nelson and Karop, in a paper read before the Quekett Club in 1886: "On the Finer Structure of certain Diatoms," say of *T. favus*: "The coarse areolations are hexagonal in form and very deep. At the bottom of these is a delicate perforated membrane, the perforations being circular and arranged for the most part in rows. Figure 3 shows a fracture, passing through the minute perforations, the resolution of which may be considered one of the most crucial tests for the microscope of the present day." The drawing in question shows the walls of the hexagons sharply outlined, with little dots at the corners, which the present writer only finds upon focusing lower down from that side.

It was, in fact, a case of not being able to see the forest for the trees. By the sheerest good luck the writer happened upon one where most of the trees had been felled, as it were, and thus was able to see things in their proper relationship. This is the view he now wishes to place before microscopists through the pages of "KNOWLEDGE." The normal appearance of this diatom is shown in Figure 387 magnified six hundred diameters, yet to be well seen it should be enlarged some three or four times more. Another view would show the white dot instead; only, after all, a question of focus. Figure 388 is part of the same valve magnified two thousand five hundred diameters, in which the white dot is represented.

Then, using the same dry lens, he came upon one looking rather queer. Naturally, the desire was to find out the cause of this divergence from the normal, and a one-twelfth inch oil immersion was substituted, when the appearance was as shown in Figure 389, magnified one thousand five hundred times, taken from one corner of the same valve. It was here simply a question of torn structure spread all over the surface, from which it would have been quite easy to produce another half-a-dozen specimens, had it served any good purpose. Figures 390 and 391, taken on a larger scale from the same valve, and showing the white and black dot aspect respectively, illustrate his views of the normal structure of this side. The reader can take whichever rendering he likes, though one thinks a great deal too much is being made of this white and black dot business. The climax of astonishment is arrived at, certainly, when one hears of ten optical level sections of a diatom photographed between the points of the two dots. These refinements of manipulation seem as little relevant to fact as was the ancient academic discussion: "Whether a thousand angels," or was it ten thousand? "could dance on the point of a needle." It will be seen in Figures 395 and 396 that there is not the slightest difference, either in size or contour, between the two aspects.

The opinion already given, in the article in August and September numbers of "KNOWLEDGE" for last year, was that the conventional appearance of diatoms, at least in the finer forms, is not the real structure. More recent researches of the writer only tend to confirm that opinion, which the various prints presented here should prove. The torn structure of *T. favus* all takes on the same character as the fibrils in *P. formosum* and of the *Pleurosigma* generally. They assume the same zig-zag, or wavy shape, either long or short, as the case may be. In *Pleurosigma* they stretch lengthways upon the valve without interruption from end to end. Here in *Triceratium*, and the discoid forms, they are found in short lengths only, springing from the structureless parts covering the tops of the hexagons immediately above the enclosing walls. Loosely thrown together they are easily torn, and to this we are indebted for the knowledge of their structure. As if to remove the last reasons for doubt, in some instances a single fibril is found sticking out by itself, only connected at one end to the structureless membrane. Figures 390 and 391 illustrate both the zig-zag formation of the fibrils, and how they combine to produce the appearance of the hexagons similar to those on one side of the valve of *P. angulatum*. It must be understood that most of the structure is torn away here, leaving all the more opportunity to judge of the remainder. Both pictures are taken from the same spot with only just a slight change of focus. Where marked with a × they show in what manner the minute hexagons are formed, one focus presenting them black and the other white.

If the reader will now refer to the article of last year he will find in Figure 18, from the inner side of the valve of *P. angulatum*, a single detached fibril. It is of the usual wavy pattern. On each side is a clear space, and, both above and below, the regular untorn structure, showing how the hexagons are formed by other fibrils.

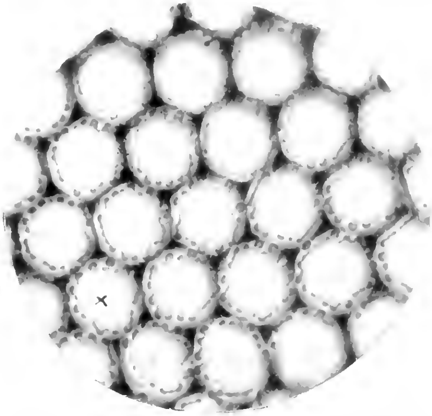


FIGURE 395. *T. favus*, from fragment of another valve, showing the same characteristics of torn structure. Magnified two thousand diameters.

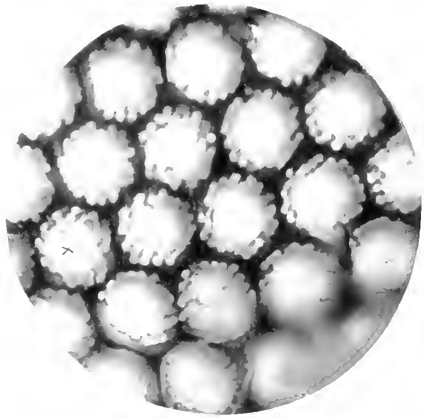


FIGURE 396. The same as last, but at another focus, showing that neither the size nor shape of the irregular structure changes in passing from black dot to white.

Figure 392 of the present article (magnified three thousand diameters) is taken from the centre of the same valve of *T. favus*, and should prove interesting both as an example of high direct magnification and for what it shows. In two divisions the structure is torn away, two fibrils are arranged in a circular direction and behind one, where marked, is seen a series of white dots similar to that we shall find directly in *Coscinodiscus asteromphalus*. Of course, at another focus the dots would be black and the enclosing structure white.

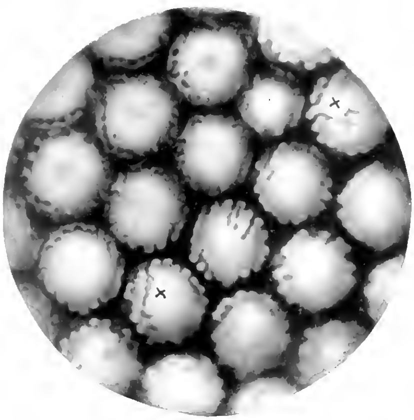


FIGURE 397. *T. favus*, from another part of the fragment. Magnified two thousand diameters.

Figures 393 and 394 are from the fragment of another valve, Figure 397 showing the interspaces almost denuded of fibrils, and Figure 392 the large hexagons immediately underneath. The first Figure should dispose once for all of the opinion that the finer structure lies at the floors of the hexagons. (As a matter of fact they have none.) An irregular-shaped structureless membrane is stretched over the top of them, hiding the contours altogether. Where the ends of the fibrils have been broken off is indicated by the stumps left, and between them are caught little points of light, showing how the focal images are produced when the structure is sound. One fibril, though but faintly shown, is left by itself stretching into space; in another part, marked with a ×, the top covering is torn away entirely; but upon focusing down (Figure 392) the hexagons are untouched. Where the hexagons are ruptured, also, is not the part. Attention is called in this last print to the large discs, characteristic of this genus. They correspond to a great extent to the eye-spots in the discoid forms, only much larger.

The next three figures, 395, 396 and 397, are from the fragment of another valve. Figures 395 and 396 are the same, the focus slightly altered. Figure 397, one view only, is from another part of the same fragment. And here the writer wishes to call attention again to certain peculiarities of structure. He was very much puzzled at this, because they did not conform to his theory, and he could not say in his heart: "So much the worse for the facts." It will be seen, on reference, that Messrs. Nelson and Karop speak of the perforations as circular, and arranged for the most part in rows. Now, given a membrane, in which are either stamped holes or has bosses raised upon a solid surface, it did not matter one jot for the theory however irregular.

Unfortunately, the present writer's theory was formed on less elastic lines. Believing that the familiar appearances are not structure at all, but only focal points of light caught between parallel (more or less) rows of fibrils of wavy outlines, the patchy irregularities would not fit in, and they do not. Yet they can be accounted for without destroying his theory, and the reason is apparent in the prints here marked. As a rule, in *Triceratium* the fibrils take the usual zig-zag course, parallel to each other, but in places where they form leaf-like expansions, take on eccentric shapes, and commit other vagaries to puzzle a poor microscopist with new theories of structure. These leaf-like expansions are further shown in two places upon Figures 388 and 392.

(To be continued.

A BRIEF MATHEMATICAL CONCEPTION OF TELEPATHY.

By L. C. POCOCK, B.Sc.

THE operation of the human brain is more completely shrouded in mystery than is any other function of our body. We have not even an elementary insight into the process by which our brain so precisely stores a thought, recalls the past, or, travelling further into the unknown, influences another brain, producing "Telepathy."

Telepathy is here defined as the action of one brain upon another without any physical contact, and includes Hypnotism when this is effected without contact. When there is contact, there is always the possibility of "muscle reading," or it may be that the sensory nerves in the hand, though accustomed only to reflex action impulses, can also transmit thought impulses which reach them in some way analogous to leakage or conduction from the true brain.

The basis of the present article is one single fact which we do know about the brain. We know that the brain requires nourishment to exercise its functions, and that when called upon to perform extra study, extra nourishment must be supplied. From this it follows that the operation of storing a thought or recalling one already stored is effected by the absorption of a certain amount of energy.

It is an interesting fact that "thinking" is not a reversible process. In committing an idea to memory, and in subsequently recalling it, energy is absorbed, although the one process seems to be the reverse of the other and to represent an opposite function of the brain; in one case we have the reception of an incoming thought, in the other, the formation and production of an outgoing thought. We cannot deliberately forget; forgetfulness is only a slow process represented by the gradual "leakage" or dissipation of that stored energy which was the thought.

We will now consider the possibility of a mathematical expression for cerebral reception and production. To commit to memory a fact we repeat it mentally several times; each repetition requires the expenditure of a certain amount of energy in the brain and we may say the energy expended after *n* repetitions amounts to

$$1^2 + 1^2 + 1^2 + \ldots n \text{ terms.}$$

Subsequently we recall the fact, the brain "produces" it: then even if we consider this process as the reverse of the other, the selection of the arbitrary function as a square gives the change of energy as

$$(-1)^2 = +1^2$$

which therefore represents energy added, or in other words, the effort of recalling a fact strengthens the memory of that fact, which agrees with our experience.

It is possible, however, that for each repetition, the amount of deposit, transformation, or whatever it is that occurs, is for that particular repetition less than for the preceding one; that is to say there is a practical limit to the amount of effect that can be produced. Instead of the series first given we might have one such as

$$\sum \left(\frac{1}{f(n)} \right)^2$$

where f(n) continuously increases. If, as seems probable, it is impossible to learn a fact beyond a certain limit equivalent to a saturation of the brain, then this series is convergent.

If we accept this theory and assume that the amount of energy fed to the brain for each term is always the same, it follows that for each succeeding term there is a greater amount of surplus energy to be accounted for. What then becomes of the surplus energy? Energy cannot be destroyed, and must in this case either be frittered away locally, as for example, heat, or it must be radiated directly. Even if none is *directly* radiated, a part is possibly transformed into radiant energy as a consequence of the commutation of thought energy into (as supposed) heat, because energy transformations are rarely completely from one form to one other only, the mechanism of the process usually resulting in some loss as regards the transformation, and the lost energy is often radiated. If we assume that in committing a fact to memory, the energy expended, as the fact becomes more familiar, diminishes in proportion to the effect produced instead of remaining constant the last argument supports the possibility of radiation, since there is still an energy transformation from the Potential Energy of nutriment to the Potential Energy of Thought or Brain.

We cannot conceive of force acting at a distance without the interposition of some medium. Electric and magnetic forces are attended by stresses in the aether: light and heat are propagated by wave motion of the same medium. Gravity alone is so familiar to us that we think but little of the process by which two apparently unconnected bodies attract each other. So, in telepathy, when two apparently unconnected brains influence each other it is reasonable to suppose that one radiates energy and the other receives energy and converts it into its equivalent, "thought."

We will postulate that from the considerations stated, telepathy is a case of radiant energy. The immediate result is that we must expect the intensity of action to be inversely proportional to the square of the distance. Such a law has not, however, been observed, and there is, indeed, no evidence that telepathy is even increasingly difficult with increasing distance. But this presents no difficulty. The brain is accustomed to "thinking": that is to say it is well practised in dealing with thought energy, in storing and radiating energy. As a receiver of external thought energy, however, the brain is far less perfect in consequence of being so little exercised in this capacity: its sensibility and capacity are small, so small that the receiver is saturated, or receives the maximum impression from the feeble intensity existing at even the greatest distance from the primary brain over which telepathy has been observed. In general an excess of energy passes on, unable to produce any effect upon the already saturated brain.

Whether the human brain is slowly improving in its capacity as a receiver, or not, cannot be determined: by all the reasoning of Evolution it is probably not. Professor Drummond points out in "The Ascent of Man" how the need of language to primitive man induced attempts at this art resulting in the evolution of a modified mouth which made possible the modulations and inflections of true language. For telepathy, however, there seems no need at present, and the function, feeble as it is, is not exercised appreciably. It may yet be proved that every feeling of sympathy and affection is the result of unconscious telepathy, and in that case there is no reason that the function should not improve. A new evolution of man may find a conscious use for this wordless thought language: a higher and more delicately made creature than man as he now is, may require this power to call for and express sympathy, to promote true mutual understanding, friendship and affection.

SOLAR DISTURBANCES DURING JULY, 1912.

By FRANK C. DENNETT.

THE Sun's disc only appeared quite free from disturbance on five days during July, namely, from the 20th until the 23rd, and on the 31st. Dark spots, however, were only seen on nine, July the 3rd, and from the 5th until the 12th. Faculae were visible on the remaining seventeen days. The longitude of the central meridian at noon on the 1st was 274° 54′.

No. 9.—A faculic disturbance advancing from the eastern limb was seen on July the 1st and 2nd, around longitude 194°, S. latitude 15°, but on the 3rd a small black pore was seen in its midst, the place being marked by a hazy pore on the 5th, not seen after.

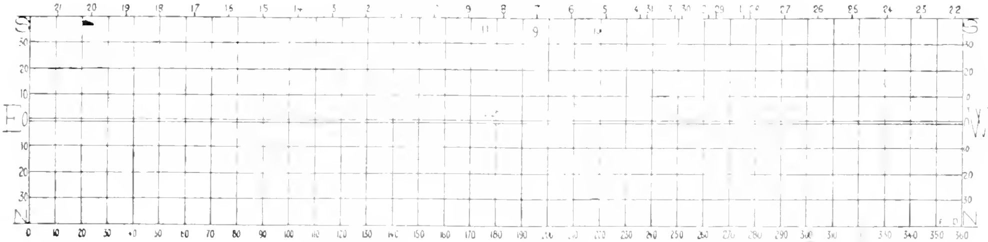
No. 10.—A tiny pore only seen on the 5th.

No. 11.—A small group of pores, traces of which first showed on the 5th. The configuration of the components varied with great rapidity, sometimes in less than an hour. The maximum length was thirty thousand miles. On the 10th at 8 a.m. a group of at least seven pores was seen, but by 7.40 p.m. it was reduced to a solitary pore, which continued visible until the 12th, its faculic remains being seen on July the 13th and 14th nearing the western limb.

A small bright double faculic knot was observed near the western limb in longitude 210° on July the 12th, and two small ones within the eastern limb near longitude 58°, 18° N. latitude, and 61°, 11° South. From the 14th until the 17th, a faculic disturbance was seen at longitude 27°, latitude 7° South, and on the three later days a disturbance was also seen at 19°, 13° South. On the 18th the faculae from longitude 329°—309° were recorded, and a small one on the 24th and 25th at longitude 32°. On the 26th, there was a brilliant knot at longitude 19°. On the 28th a bright region was situated around longitude 213°, North latitude 39°, and the streak in longitude 341°. Also on the 30th a small bright facula was seen close to the equator at longitude 181°.

Our chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, C. P. Frooms, and the writer.

DAY OF JULY, 1912.



THE FACE OF THE SKY FOR OCTOBER

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Day	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A. Dec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 36.

Date.	Sun. P	B	L	Mars. P	[illegible] P	[illegible] P	Jupiter. L_1	L_2	T_1	T_2	Saturn. P	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 37.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T_1 T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN moves South pretty rapidly. Sunrise during October changes from 5–59 to 6 53; sunset from 5–41 to 4 35. Its semi diameter increases from 16′ 0″ to 16′ 9″.

MERCURY is in superior conjunction with the Sun on October 4th, and may be seen in the evening at the end of the month, especially by Southern observers. Throughout the month the disc is nearly fully illuminated, semi diameter $2\frac{1}{2}$″.

VENUS is an evening Star, but too near the Sun for convenient observation. Illumination nearly complete, semi-diameter $5\frac{1}{4}$″.

THE MOON.—Last Quarter $3^d\ 8^h\ 48^m e$; New $10^d\ 1^h\ 41^m e$; First Quarter $18^d\ 2^h\ 6^m m$; Full $26^d\ 2^h\ 30^m m$. Perigee $7^d\ 7^h e$, semi-diameter 16′ 23″; Apogee $19^d\ 2^h e$, semi-diameter 14′ 48″. Maximum Librations, October 3^d 7 S., 13^d 6 W., 17^d 7 N., 26^d 5 E. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is an evening Star, but practically invisible.

JUPITER is an evening Star, increasing its distance from us, so that the equatorial semi-diameter diminishes from 17″ to 16″. The Polar is smaller by $1\frac{1}{4}$″. The configurations of the satellites at $6^h e$ are for an inverting telescope.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912			h. m.		h. m.	
Oct. 2	136 Tauri	4·6	0 8 *e*	100	0 53 *e*	253
" 4	ω² Cancri	6·2			11 4 *e*	203
" 5	λ Cancri	5·9	6 38 *m*	168	7 16 *m*	230
" 6	BD 21 1906	7·7			6 43 *m*	210
" 20	29 Aquarii (double)	6·5	4 18 *e*	40	5 27 *e*	200
" 26	30 Arietis	6·5	8 54 *e*	106	9 40 *e*	191
" 27	BD 22 523	7·0			10 5 *e*	270
" 28	BAC 1170	5·5	2 18 *m*	91	3 28 *m*	234
" 29	BAC 1749	6·5	7 59 *e*	47	8 44	200
" 30	BAC 1848	5·6	2 27 *m*	114	3 35 *m*	239
" 31	Geminorum	5·5	8 59 *e*	101	9 40 *e*	206

TABLE 38. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Day.	West.		East.		Day.	West.		East.	
Oct. 1	3		41	2●	Oct. 17	2		[illegible]	
.. 2	31		24		.. 18	21		43	
.. 3	2		14	3●	.. 19			43	
.. 4	21		34		.. 20	1		234	
.. 5			1234		.. 21	2	⊙	14	
.. 6			234	1●	.. 22	32		4	1●
.. 7	231		4		.. 23	31		24	
.. 8	3		14	2●	.. 24	3	⊙	12	
.. 9	31		42		.. 25	21		34	
.. 10	423		1		.. 26			4213	
.. 11	421		3		.. 27	41		23	
.. 12	4		123		.. 28	42			
.. 13	41		23		.. 29	432			1●
.. 14	423	⊙			.. 30	431		2	
.. 15	432		1		.. 31	43		21	
.. 16	4 1		2						

TABLE 39.

Satellite phenomena visible at Greenwich. 1^d 6^h 39^m 54^s II. Ec. R.; 3^d 5^h 50^m III. Oc. D.; 5^d 7^h 33^m I. Tr. I.; 7^d 5^h 23^m I. Sh. E.; 13^d 6^h 42^m I. Oc. D.; 14^d 6^h 18^m I. Tr. E., 6^h 46^m III. Sh. E.; 15^d 7^h 13^m II. Oc. D.; 17^d 6^h 8^m II. Sh. E.; 21^d 6^h 3^m I. Tr. I.; 22^d 6^h 19^m 22^s I. Ec. R.; 24^d 6^h 1^m II. Sh. I.; 29^d 5^h 13^m I. Oc. D; 30^d 4^h 40^m I. Tr. E., 5^h 37^m I. Sh. E.

All the above are in the evening hours.

The eclipse reappearances of I. II. and both phases of those of III. occur high right of the inverted image, taking the direction of the belts as horizontal.

SATURN is a morning Star. Polar semi-diameter 9¼″. The major axis of the ring is 46½″, the minor axis 19½″. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). October 2^d 2^h·1 e, 10^d 3^h·3 *m*, 17^d 4^h·5 e, 25^d 5^h·7 *m*. Dione (every third given). October 2^d 11^h·2 *m*, 10^d 4^h·2 e, 18^d 9^h·2 e, 27^d 2^h·2 *m*.

Rhea (every second given). October 2^d 5^h·2 e, 11^d 5^h·9 e, 20^d 6^h·7 e, 29^d 7^h·3 e.

For Titan and Iapetus, E. W. mean East and West elongations, I., S. Inferior and Superior Conjunction, Inferior being to the North, superior to the South. Titan, 3^d 5^h·6 *m* W., 7^d 4^h·2 *m* S., 11^d 7^h·3 *m* E., 15^d 7^h·0 *m* I., 19^d 3^h·6 *m* W., 23^d 2^h·0 *m* S., 27^d 5^h·1 *m* E., 31^d 5^h·5 *m* I. Iapetus 4^d 5^h·8 e W, 23^d 2^h·6 e S.

URANUS is an evening Star, semi-diameter 2″. It is 7½° South of Alpha Capricorni, 5° South-West of Beta.

NEPTUNE is a morning star, not yet very well placed.

METEOR SHOWERS (from Mr. Denning's List):

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
July to Oct.	355	72	Swift, short.
Aug. to Oct. 2	74	42	Swift, streaks.
Sept. 28 to Oct. 6	32[illegible]	40	Slow, small.
Oct. 2	230	52	Slow, bright.
.. 4	310	79	Slowish.
.. 8	77	31	Swift, streaks.
.. 8–24	45	58	Small, short.
.. 14	133	68	Rather swift.
.. 15	51	9	Slow.
.. 18–20	92	15	Swift, streaks.
.. 23	10[illegible]	13	Swift, streaks.
.. 29	100	23	Very swift.

CLUSTERS AND NEBULAE.

Name.		R.A.		Dec.	Remarks.
M.	52	23^h	20^m	N 61·1	Cluster.
H IV.	18	23	22	N 42·0	Spiral nebula.
H VI	30	23	52	N 56·2	Cluster.
H V.	18	0	35	N 41·1	Large faint oval nebula
M.	31	0	37	N 40·8	Great nebula in Andromeda.
M.	32	0	37	N 40·8	
H VIII.	78	0	38	N 61·3	Cluster "Like letter W" Between γ and κ Cassiopeiae.

DOUBLE STARS.—The limits of R.A. are 23^h to 1^h.

Star.	Right Ascension. h.	m.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
94 Aquarii	23	15	S 13 ·9	5, 7	340°	13″	Yellow, blue.
o Cephei	23	16	N 67 ·6	5, 8	190	3	Yellow, blue.
Lalande 47034	23	55	N 33 ·2	6, 6	215	2	Yellowish.
Lalande 47200	0	[illegible]	N 33 ·8	7, 7	152	½	Yellow.
There is a ninth mag. star, distant 23″.							
Bradley 3210	0	2	N 58 ·0	7, 8	354	1½	Yellow, bluish.
Period of revolution, 114 years.							
Bradley 3217	0	5	N 79 ·2	6, 7	140	[illegible]	Yellow.
55 Piscium	0	35	N 21 ·0	5, 8	191	7	Yellow, purple.
η Cassiopeiae	0	44	N 57 ·3	4, 8	240	6	Yellow, purple.
Period of revolution, about 213 years.							
65 Piscium	0	45	N 27 ·2	6, 6	117	4	Yellowish.
36 Andromedae	0	50	N 23 ·2	6, 7	21	1	Yellow.

TABLE 40.

CORRESPONDENCE.

STEREOSCOPIC STAR CHARTS.

To the Editors of "KNOWLEDGE."

SIRS.—I have read with interest the article in your June number by Mr. A. H. Stuart, on Stereoscopic Star Charts. I should have left to Mr. T. E. Heath the task of commenting on the question of priority as to his method of graphically illustrating the relative distances of the stars, but for the fact that the author makes the statement that stereoscopic lantern slides of stars have been placed on the market by "an American firm." It was as long ago as May, 1906, that Mr. T. E. Heath, F.R.A.S. approached my firm (Flatters and Garnett, Ltd.) and I then undertook some experiments with a view to reproducing, by a photographic process, the stereographic charts and transparencies which Mr. Heath had prepared. He had been successful in making the slides by hand from sheets of gelatine, one red and one green, with the stars pricked out as holes in [illegible] way that when superimposed the "pairs" of stars (red and green) showed up brightly on a very dark purple background. It is needless to recapitulate the many experiments undertaken, but some details of the technique [illegible]lly adopted and still (with some modifications) pur[illegible] by my firm, may be of interest:

(1) Mr. Hea[illegible] [illegible] a pair of large scale star maps of each selected are[illegible] [illegible]e same stars were shown on each half, but their posit[illegible] laterally varied with their differences in parallax. [illegible] stars were drawn as black discs on a white ground [illegible] in diameter varying with their magnitude.

(2) From each half of the chart a negative was prepared [illegible]ctly the same scale, and of a size suitable for a lantern [illegible] one half (the right) was reversed, *i.e.*, taken through the back of the plate, for reasons that will presently be evident.

(3) From these negatives—(white stars on a black ground) fresh positives were now prepared, in which the stars were once more black on a white ground.

(4) The next step was the sensitizing—by a modification of the bichromate or carbon process—gelatine films on glass plates three and a quarter inches by three and a quarter inches. When dry, these films were printed from the positives obtained in (3), and, after exposure, developed in the usual way of carbon printing with warm or hot water. If successful, the stars, being unacted on by light, washed out completely, leaving bare glass, the background being still strongly adherent and insoluble.

(5) The right-hand slide was then bathed in a dye bath of the correct red tint, and the left hand one in a bath of green dye. The dyes were selected so as to be as near as possible complementary, so that when viewed together by transmitted light the films were nearly opaque (really a very deep purple blue).

(6) On now placing the two halves with the films face to face, the holes in the red half appeared green, while those in the green appeared red. It will now be seen why it was needful to reverse one half. If not reversed the one film would have had to have been placed to the outside of the slide, which would not have answered.

(7) Finally the slides were bound up into position; any little errors of printing resulting in the pictures not coinciding being adjusted before binding. On viewing against a light, or on a screen, each pair of stars now shows up as a red and green disc, the star in each pair varying in distance from its fellow. Thus, the most distant stars almost touch, while the nearer ones are some way apart. Spectacles with suitably coloured gelatine glasses are put on when looking at the slides, when the pairs combine as one star and stand out apparently in mid-air.

A curious phenomenon may here be mentioned; if the red glass is held to the right eye, and the green to the left, *i.e.*, in the same position as the colours on the slides, the stereoscopic effect is still seen, but the stars appear to stand out *behind* the screen, and the nearest stars are seen as most distant; with the spectacles reversed, the nearest star approaches apparently nearest to the eye, in front of the screen.

Later, large transparencies, to hang in windows, were prepared, and to my mind these are more beautiful and effective and easier to see stereoscopically than the lantern slide projected on a screen. For the later the disc should be small, and the audience at a fair distance from the screen.

Perhaps the most unexpected truth that these stereograms have demonstrated to the public is that the largest stars are not necessarily the nearest!

HENRY GARNETT, F.C.S.

32, DOVER STREET,
MANCHESTER.

We are pleased to announce that Messrs. Flatters and Garnett are still prepared to make slides of the transparencies in question.—EDS.

SPECIAL APPEAL FROM THE RESEARCH DEFENCE SOCIETY.

To the Editors of "KNOWLEDGE."

SIR,—We are of opinion that experiments on animals in this country should be restricted by law, that the present Act should be efficiently administered, and that the utmost care should be taken to ensure the minimum of pain in these experiments.

Some of the anti-vivisection societies have lately adopted methods which are grossly offensive to the public interest. They have opened no less than sixty shops in London and elsewhere. Most of these shops have lasted only a few weeks: but they have had time to spread falsehood, prejudice, hatred, and suspicion against scientific research. They have also done harm to small children. It is no light offence to exhibit in public not only brutal cartoons and caricatures, but stuffed animals, tied down for operation, while the truth is carefully concealed that no operation is allowed on any animal in this country, except under an anaesthetic.

In this connection, we would remind the public of the unanimous statement of the Royal Commission:—"To represent that animals in this country are wantonly tortured would in our opinion be absolutely false."

The excuse is offered, for these shops, that the appliances displayed in the window are actually supplied by the makers. But if the appliances used in our Hospitals were displayed in a shop-window, with models of human beings tied down for operation, it would be no excuse for such a travesty, to say that the appliances had actually been supplied by the makers.

Some of these societies, having wealth at their disposal, are able to rent shops in the most crowded thoroughfares, or to attract, by the very lavish and rather unscrupulous use of money, a large audience. It seems that an effort is being made to work on the mere liking for horrors, real or sham: that no exhibit is too sensational, if it can serve to draw attention and to excite passion.

When we think of the vast multitudes of lives, human and animal, saved from pain, disease, and death, by discoveries made through experiments on animals, we cannot believe that the present methods of anti-vivisection societies are acceptable to sensible and honest people.

The only way to fight these methods is to be constantly publishing the facts of the case put before the Royal Commission and embodied in its final Report. The Research Defence Society, in the past twelve months, has given more than a hundred addresses and lantern lectures in all parts of the kingdom, and has distributed more than half-a-million pamphlets and leaflets. But there is much more work waiting to be done, if we had the money for it. We therefore appeal for special donations, to be controlled by the Committee of the Society, and to be used solely for such purposes of education as public lectures and distribution of literature. All cheques should be crossed Messrs. Coutts & Co., and made payable to the Hon. Treasurer, Research Defence Society, 21, Ladbroke Square, London, W. We hope and believe that this appeal, in the interest of the public, will be very generously answered.

On behalf of the Society,

We remain,

Yours faithfully,

DAVID GILL, President.
SYDNEY HOLLAND,
Chairman of Committee.
ROBERT CECIL.
LUKE FILDES.
WILLIAM RAMSAY.
MARY SCHARLIEB.
F. M. SANDWITH,
Honorary Treasurer.

21, LADBROKE SQUARE,
LONDON, W.

THE ROTATION OF VENUS.

To the Editors of "KNOWLEDGE."

SIRS,—By an error of reduction the period determined by Mr. J. McHarg is given on page 305 as $23^h\ 28^m\ 13^s{\cdot}595$, he however, has kindly pointed out that it should be ·9776803 days, or $23^h\ 27^m\ 51^s{\cdot}58$. I should, therefore, be glad if you would kindly insert the correction.

FRANK C. DENNETT.

THE SECOND LAW OF THERMODYNAMICS AND PROFESSOR BICKERTON'S THEORY.

To the Editors of "KNOWLEDGE."

SIRS,—*The English Mechanic*, of August 2nd, reprints an article from *The General Electric Review*, by C. P. Steinmetz, Chief Consulting Engineer of the General Electric Company, on "The Death of Energy." This article confirms Professor Bickerton's views published in the December number of "KNOWLEDGE," in which he shows that the second law of thermodynamics is not of cosmic application, and that the eternity of life is physically possible. Steinmetz's article commences by a very full and varied series of illustrations of dissipation of energy. He then goes on to say:—"The second law of thermodynamics is well founded on our experience. The reasoning from this law as to the death of the universe is logical. At the same time, the conclusion that the universe must run down is not reasonable. If the universe is eternal, has existed since infinite time, then it should have run down an infinite time ago. But if it is not eternal, but had a beginning, what was before? Thus, in the final reasoning, we arrive at a contradiction. The explanation may be either that we have attempted to reason beyond the limits of the capacity of the human mind, which, being finite, always fails in the attempt to reason into the infinite, or it may be that the second law of thermodynamics is not of universal application; is not a general law of nature, but is of limited application only. In the following pages I wish to show that the latter is the case. A single exception, obviously, would be sufficient to show that the second law of thermodynamics is not a universal law, and that the conclusions regarding the death of the world, based on this law, are thus not justified. As the thermodynamics of gases is far simpler and more completely known than any other branch of thermodynamics, it would offer the most promising field of study. The kinetic theory of gases is probably as fully and conclusively proven as anything can be, by the inductive method of science." The author then discusses Clark Maxwell's demons, and says "Now, these demons exist in Nature. Every cosmic body is such a demon, and separates the fast from the slow molecules, keeping the latter and sending the former out into space, and thereby causing heat energy to flow into space, at a temperature far above its own temperature. . . . . . . If, however, the upward velocity of the molecule is sufficiently high—above a certain critical value—then this molecule escapes from the attraction of the earth into space, and never comes back." Then Steinmetz shows, as Bickerton has previously done, that molecular motion may cease to be heat. He says: "We may ask, however, whether the kinetic energy of a molecule which, due to its high velocity, has escaped into cosmic space, can still be considered as heat energy. Heat energy is the kinetic energy of irregular molecular motion. The difference between the heat energy of a gas and mechanical energy thus lies in the irregularity of the motion and the size of the moving particles, which is such that only the resultant effect of the mechanical motions of large numbers of moving particles can be perceived. Irregularity of motion, however, is relative; for if we consider a single molecule which has escaped into space, by reason of its high velocity, we cannot attribute any irregularity to its motion. That is to say, its kinetic energy cannot further be considered as heat energy; but the kinetic energy of the molecule, which has heat energy, while the molecule moved in a mass of gas together with other molecules, is mechanical energy of cosmic motion, and the molecule is a cosmic body traversing space under the laws of gravitation, but not subject any more to the law of probability of mass action—*i.e.*, to the second law of thermodynamics." He then shows by very lengthy argument that this new energy is not heat, and says—"When, however, the kinetic molecular energy ceases to be heat energy, the second law of thermodynamics, which is the application of the law of probability, also ceases."

He then gives a long discussion showing that this new energy clearly does not conform to Kelvin's law, and concludes by saying "We are thus led to the conclusion that the second law of thermodynamics is not a universal law of Nature, but applies only within the limited range of thermodynamic engines from which it has been derived. It does not apply to the universe as a whole; and the conclusions derived from it, that the universe must finally come to a standstill, are not justified."

Clearly Steinmetz has been led to this view by his own independent reasoning, his terms being wholly different from Bickerton's. When it is considered that Bickerton used the term, "selective molecular escape" and showed that it overcame dissipation of energy, a third of a century ago, it is obvious he has the priority of the idea. It will be observed also that Steinmetz says nothing of the "aggregating power of the position of high potential" which Bickerton shows to be a cosmic collecting agent for light elements in contrast to gravitation, which tends to collect and concentrate heavy elements. In this way Bickerton shows that both sides of the doctrine of physical death, namely, the degradation of energy and the concentration of matter, have each of them agents acting in the opposite direction. So that the whole cosmic scheme is like the differential governor of a steam engine, constantly tending to equilibrium.

In the August, 1911, "KNOWLEDGE," in Physics notes, you gave Kapteyn's observations that tended to confirm Bickerton's theory of the origin of the universe. In the June meeting of the B.A.A., fully reported in their journal, Bickerton shows that the Cambridge series of the spectrograms not merely demonstrated that Nova Geminorum was actually a third body struck from grazing suns, but that these spectra also exhibited most clearly the action of axial extrusion of selective molecular escape, and the pulsation of the nucleus, described in the September number of "KNOWLEDGE."* Thus it seems that all the essential facts of the New Astronomy are demonstrated by independent observations and reasoning.

SYLVESTER N. E. O'HALLORAN.

GRAY'S INN.

FERTILIZATION OF THE FIG.

To the Editors of "KNOWLEDGE."

SIRS,—I should be very grateful if Professor Cavers would point out how far his very interesting paper on "The Fertilisation of the Fig" is applicable to the fig of our English gardens. As far as I have been able to observe there are no small wasps frequenting the trees, nor have I seen apertures at the top of the pear-shaped receptacle large enough to admit any but the very smallest insect. Neither can I find the three crops of inflorescence spoken of. I am sure any information on the subject would be welcomed gratefully by all interested in such a branch of botany.

I. L. J.

DISCAL FLORETS OF COMPOSITAE.

To the Editors of "KNOWLEDGE."

SIRS,—Sir W. W. Strickland appears to be endeavouring to construct a theory of the arrangement of disc florets on a basis of concentric circles, but Nature really knows nothing of circles, only *spiral whorls*, resulting from the projection of portions of a continuous spiral on to a plane. For example, the aestivation of the lobes of gamopetalous corollas reveals

* "KNOWLEDGE," August, 1912.

this fact, though the united petals may form a cylindrical tube with a circular section.

In reducing the florets to circles, as shown in Figure 330, the result is not in accordance with Nature; for if a large sunflower be examined, it will be seen that it is just like a suppressed cone, the florets being arranged in *radial curves*, corresponding to the secondary spirals on a fir cone; these curves are like the ornamentation on the back of a watch, only the curved radii are thirty four and fifty five respectively, running in opposite directions. These supply the divergence $\frac{21}{55}$ in the usual way of the generating spiral.

Inexactnesses are always liable to occur in crowded structures, in consequence of the suppression of some; so that the true maxima have usually subordinate ones on either side of them; but the origin is ***always spiral*** and not ***circular***. Of the "three possibilities" the author gives, the first, that "the discal florets may represent phyllotaxis numbers or their doubles" is the only one possible, except multiples of fives; but these only occur in simpler conditions, as in pentamerous flowers.

For further details I would refer any reader interested in phyllotaxis to my several papers in the ***Transactions of the Linnean Society***.

GEORGE HENSLOW.

Bournemouth.

REVIEWS.

ASTRONOMY.

Astrographic Catalogue. 1900·0. Perth Section. Dec. −31° to −41°. Vol. I.—By W. Ernest Cooke, M.A., F.R.A.S. 52 pages. Vol. IV. 72 pages. 12-in. × 9¾-in.

(Perth, Australia: Fred. W. Simpson.)

We welcome these portions of two volumes, though small, from the Perth Observatory, W. Australia, as being the first that have yet been published concerning any portion of the southern half of the sky, except a small section near the equator from Algiers. We usually associate clear skies with the southern hemisphere; but, considering that all the eighteen participating observatories started or might have started this survey work in 1892 (the Perth Observatory was only founded in 1896 and agreed to take on the section which was at first allotted to Rio de Janeiro) we must either modify our opinions or assume that the great delay in making the preliminary results of the survey available for astronomers is solely due to want of energy and proper organization. As we are well acquainted with the various reasons for the delay we can say that the sky has not been the cause; this might well have been advanced as the cause at three northern observatories, Helsingfors, Greenwich and Oxford, but the last two have alone, of the eighteen, measured and published their portions, about two hundred thousand stars each.

The two sections with which we are now concerned contain five thousand six hundred and forty-six and thirteen thousand six hundred and thirty-six star images in −32° zone, R.A. 0^h to 6^h, and 18^h–0^h. The size of the page is that of Greenwich and Oxford, and the general arrangement of the material on the pages closely resembles that adopted at Oxford. The points of difference are, that three instead of five groups of columns are put on a page—we think four would have been best; that undue space—two wide columns—is given to the magnitudes; and that instead of making the numbering in sequence for a whole zone it starts with one for each plate; as there are one hundred and sixty plates in each zone that means there will have to be one hundred and sixty breaks and the same numbers will be repeated one hundred and sixty times—or at least the first hundred or so—in the same zone. The only distinguishing point in each instance will be the R.A. of the plate centre; so we must use a cumbersome notation. Brevity is what we should aim at, and say a star is

−32° R.A. 5^h 51^m No. 229

instead of

−32° 5646.

The non-repetition of the *reseau* interval where it changes in *y* is a source of error in the practical use of the work. There is room for much economy of space or printing; when a plate ends, the rest of the column is left blank: the blank space on a page is frequently one quarter to one half of the page. We thought paper and printing were expensive in Australia. If we take Vol. I, R.A. 0^h–6^h, the measures occupy thirty-four pages of three columns each; in those pages there is an equivalent of more than nineteen blank columns, thus about twenty *per centum* of the whole is wasted. Economy might be considered here. We venture to urge that the name of the Observatory, Perth, should be printed on each page, as there will be Astrographic Catalogues from seventeen other observatories! though we do not expect them all to be available for astronomers' use before 2000.

In the methods of measurement and reductions, and in the formation and arrangement of the tables for reduction, those brought into use by Professor Turner (Oxford) have been closely followed: it is of the greatest advantage to have some uniformity in this international survey work, though unlimited time and money ***might*** produce better results. The magnitudes are designated by letters according to Mr. W. E. Cooke's own scheme, explained on pages 8 and 9 of Vol. I.

Though we congratulate Mr. Cooke in having set the lead for the southern sections, especially as he started some years later (Algiers work is just the part to the north and south of the equator), we should have preferred even a little more delay and got a complete volume out at a time; this would save cost in binding and time in distribution; the numbering might have then run on from plate to plate.

F. A. B.

Catalogue of 2,013 ***Stars between*** *35° and 37°* ***S. Dec.***—By W. Ernest Cooke. 122 pages. 12¾-in. × 10-in.

(Fred. W. Simpson.)

The book before us is the fifth of this series of meridian observations made with the Troughton & Simms six inches in diameter object-glass at the Perth Observatory, West Australia.

This volume contains the positions of two thousand and forty-three stars between −35° and −37° declination derived from observations made so recently as in the year 1910. This speedy publication of a considerable catalogue of meridian work is highly commendable to Mr. W. E. Cooke and the assistants who contributed the bulk of the work, and is quite contrary to the usual long interval between observations and publication. It is a valuable catalogue for southern astronomical photography.

The primary object of this series of catalogues is to provide good meridian places for those stars upon which to base the corrections of the photographs being taken at Perth for the Astrographic Survey. A minimum of three stars scattered over each square degree is aimed at; that would afford twelve to fifteen reference stars on each plate; being observed nearer the epoch at which the photographs are exposed than is usual, the proper motions have a less disturbing effect. An average of three observations for each star has been maintained. We notice that the observational work depended upon Mr. H. B. Curlewis for the transits, and Mr. C. Nossiter for the microscope readings; it is an important point not to have varying observers in meridian work. As quite fifty ***per centum*** of the stars are below the ninth magnitude we do not find that any allowance has been made for magnitude-equation; 9·5 to 10·5 magnitude stars are not easy to observe with a six-inch lens. Was any change made in the method of observing these and the brighter stars?

The catalogue itself occupies sixty-four pages; there are two appendices of fifty-eight pages consisting of blank forms for writing in corrections, as explained in Volume IV; such are of use at the Perth Observatory, but we do not think these pages will be used elsewhere: a publication containing a summary of the corrections for the whole zones would have been of greater use.

We have one criticism to make upon this and previous volumes of this series. We offer a protest against the absurd custom, originated or frequent in American publications, of inserting useless cyphers before whole numbers, such as minutes and seconds; *e.g.*, Why $1^h\ 02^m\ 08^s\cdot24$? Why not $1^h\ 2^m\ 8^s\cdot24$?

F. A. B.

Memoirs of the British Astronomical Association.—Section—Comets. Vol. XIX. Part I.

(Eyre & Spottiswoode. Price 1/6.)

The recent publication of this number brings to the front again old Halley's Comet. We have here a summary of the work of the Association's observers, and some others, upon the history, brightness, nucleus, coma, tail, spectrum, and other phenomena, written up in twenty-eight pages, by Dr. D. Smart. The second part, the orbital data, is written by Dr. A. C. D. Crommelin, whose collaboration with Dr. Cowell brought so much honour and credit to themselves and to this country, and he gets a large amount of valuable information in a concise form into six pages, illustrated with diagrams. The third part, six pages and two plates is replete with illustrations of the nucleus and tail of the comet.

F. A. B.

Stars and Constellations: A Little Guide to the Sky.—By AGNES FRY. 40 pages. 2 maps. $6\frac{1}{2}$-in. × $5\frac{1}{4}$-in.

(Clifton: J. Baker & Son. Price 6d. net.)

This booklet describes in poetic language the march of the stars during the year. We had the advantage of reading the manuscript of these lines; now we have them in print, in a neat form, in excellent type and a good paper, at a trivial cost. The authoress gives more than a line for each day of the year: there are four hundred and one lines; occasionally the rhyme or rhythm appears somewhat crude, but we do not notice any errors in the fanciful descriptions of the constellations.

To those who like to associate the constellations with verse we commend this booklet as a useful aid in remembering the configurations.

F. A. B.

BACTERIOLOGY.

Bacteria as Friends and Foes of the Dairy Farmer.—By WILFRID SADLER. 112 pages. 8 illustrations. $7\frac{1}{4}$-in. × 5-in.

(Methuen & Co. Price 1/6.)

Now that preservatives are no longer allowed in milk there is an additional reason why those who are responsible for its keeping should become familiar with the bacteriology of the dairy. The old practical methods of butter and cheese-making may be very successful, and it is always advisable to let well alone; but when difficulties arise the application of scientific methods and principles will be found most advantageous. Mr. Sadler deals with the question of pure milk supply and germ-free milk, as well as with the sources of contamination, while the first part of his book is occupied with some introductory remarks on bacteria, acid forming germs and the production of flavour by them. In his Introduction Mr. John Golding, speaking of the dairy farmer, says that it has become an absolute necessity that he should be acquainted with some knowledge of the world of microscopic beings with which he is beset on all sides, and be able to distinguish his friends from his foes among this host which he cannot see; but to which he owes, and from which he fears, so much.

BIOLOGY.

Second Report on Economic Biology.—By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S. 70 pages. 9-in. × 6-in.

(The Midland Educational Co. Price 2/6.)

We have before us the second report on Economic Biology which deals with the year 1911, and in his introduction Mr. Collinge says that the losses occasioned by injurious insects and other animals and fungus parasites during the year 1911 have far exceeded anything he has previously known. The prolonged and dry summer resulted in the maximum number of broods being produced, whilst the drought told largely against the vitality of many crops, thus rendering them unable to ward off the effects of insect or fungus attacks. On some farms and in many orchards the conditions have been pitiful; indeed, those who have taken all precautions have been no light sufferers.

A new pest of mangels and beet in the shape of *Cionus scrophulariae* Linn., which was first of all found on knotted fig-wort, has now been recorded as damaging the leaves of cultivated plants. Mr. Collinge discusses its distribution and life history. In the miscellaneous notes some observations on the food of the starling are given. The crops of one hundred and forty-six birds were examined during the first six months of the year. Mr. Collinge says that the food was of a distinctly insectivorous character in the vicinity of the city of Birmingham, and that during those months the evidence from the food generally would lead us to place this species amongst those birds beneficial to the agriculturist and horticulturist. He, however, adds that a similar record taken in an agricultural district would "in all probability reveal the starling as the destroyer of newly-sown grain, and extended over the summer months would show that it inflicts considerable losses upon fruit growers," and he further remarks "in short, we have too many starlings." He is most likely quite right, but it would be useful to have some direct evidence as to the second six months of the year; and, as the natural outcome of having too many starlings would be to destroy them, the question arises why should they be killed in the neighbourhood of Birmingham if they are there useful. Possibly, however, it might be contended that they might migrate to an agricultural district. We should, however, like to know also how the economic biologist decides whether the amount of good done by any particular bird outweighs or balances the harm which it causes.

COSMOLOGY.

The Growth of a Planet.—By EDWIN SHARPE GREW, M.A. 351 pages. 9 illustrations and numerous diagrams. $7\frac{1}{2}$-in. × 5-in.

(Methuen & Co. Price 6/- net.)

This is a class of book that at the present time is most urgently needed. From cover to cover it teems with original thought and sane suggestion. It is a careful examination of a large number of cosmic explanations, theories, and generalizations. Many of our eminent scientific thinkers have been deploring the fact that we stand a chance of being intellectually buried beneath the vast accumulations of unclassified and badly correllated facts. The last few years has shown that there is a tendency amongst scientific men generally to search for explanations and working hypotheses. It was only natural that in the past the stupendous advance in the power of our telescopes, then their being armed first with the prism and then with the photographic film, should give a great enthusiasm to observations. This book is an attempt to find out what these observations mean and their constructive value. It must aid greatly in giving order to our ideas, and will tend to introduce a system of logical classification that will render observations available for future study.

The book opens with an examination of the theories of the Birth of Systems. Professor See, in his Capture theory, shows many grounds why Laplace's ring theory must be abandoned; our author shows us many more. Having relinquished this hypothesis, he examines Chamberlin and Moulton's and shows reasons why we must accept this hypothesis with a great deal of caution. Of course, one of the most fatal objections to this theory is, that where double spiral nebulae are abundant, there are but few stars to produce them, and where stars are abundant they appear to have formed no spiral nebulae at all. Another objection is, that we should expect to find many double spiral nebulae in pairs, whereas scarcely any pairs exist. He examines the tidal, and other theories of the origin of moons and planets, and shows generally that although they have much to recommend them yet all fail in giving a thoroughly satisfactory explanation.

The main portion of this book, as its title suggests, is concerned with the geology of the Earth and its evolution as [illegible] of life, and [illegible] the theory of the [illegible] at work at the beginning of life, of the varied [illegible] of the animal kingdom with its background of [illegible] scenery and vegetable [illegible].

Mr. Grew has an interesting chapter [illegible] climate, and [illegible] the possible effect of [illegible] on this problem. He says nothing of Croll's [illegible] theory of "Climate and Time." Surely altered eccentricity to the extent of thirteen millions of miles [illegible] affect climate, and must affect ocean levels. It may [illegible] so stupendous an effect as its originator suggested, but it must have an action that would have been worth discussing in so full a treatment of the subject as is given in this book. A long severe winter in one hemisphere during which most of the polar water must fall as snow, will assuredly be strikingly different from the other polar hemisphere, where during the short mild winter most of the condensed water will fall as rain, and hence flow off, and leave the earth surface ready to be warmed at once by the summer sun; whereas the summer sun in the other hemisphere must obviously be largely engaged in melting the ice that has accumulated in the long cold winter. There is but little doubt that Croll's theory is deserving of more attention than it has received of late years. This very able book, so largely devoted to contrasting and estimating the value of rival theories, and that so clearly shows the unsatisfactory nature of most of them, will doubtless help to a revaluation of theories that have been too hastily rejected, and help much towards a solution of many problems. No impression of this book is more evident than that the study of generalizations is the urgent need of the moment. The book is heartily recommended to every one of the readers of "KNOWLEDGE"; it is as interesting as a novel, and is especially characterized by the same aim as that of "KNOWLEDGE," namely the subject is plainly worded and exactly described.

A. W. B.

MINERALOGY.

Gem-Stones.—By G. F. HERBERT SMITH. 312 pages. 32 plates. 7¾-in. × 5-in.

(Methuen & Co. Price 6/- net.)

Besides forming an excellent work of reference and giving details as to the articles and manufacture of stones and methods of mining, Mr. Herbert Smith's book is of considerable interest to the general reader. A chapter is devoted to "Historical Diamonds," for instance, and remarks are made as to the powers of resistance which stones used in jewellery should have against the mechanical and chemical actions of everyday life. Gem-stones, we are told, should be at least as hard as the minute grains of sand in ordinary dust. This is a condition fulfilled by all the principal species with the exception of opal, turquoise, and one or two others. The beauty of the first-named does not depend upon the brilliancy of its polish, so that surface scratches are not of much importance. If there is the slightest degree of porosity the stone is likely to be affected chemically. It is risky to wet turquoises, even with water, lest the bluish-green colour be oxidised to the despised yellowish hue. There is some chance of opals, moonstones and star stones being damaged by the penetration of grease into their interior, and as the charm of pearls may easily be destroyed in the same way or by contamination with grease, ink, or similar matter, while they are also soft, their use in rings is much to be deprecated. The book contains a wealth of illustrations, and the plates in three colour give a very good idea of the tints and appearance of the stones shown.

NATURAL HISTORY.

The Arctic Prairies.—By ERNEST THOMPSON SETON. 415 pages. 54 illustrations. 9-in. × 6-in.

(Constable & Co. Price 12/6 net.)

The many admirers of Mr. E. Thompson Seton's work will welcome this account of a canoe journey of two thousand miles which he made at his own expense and for his own pleasure, in search of the Caribou in the far North-West. The book consists of a graphic account of travel, of natural history observations, illustrated with thumb-nail sketches, finished drawings of animals and with photographs. In fact, [illegible] everything that was new or interesting to Mr. Seton [illegible] illustrated, from the dry wallows in which the buffaloes [illegible] relief from flies, to the footprints of the black bear and [illegible], primitive windlasses, birch bark pails, and the various [illegible] that were noticed from time to time. Mr. Seton not only [illegible] many and great herds of the deer which he went so far to find, but met with numerous things which he did not expect, and which in his own inimitable style he brings before his readers.

Wimbledon Common. By WALTER JOHNSON. 304 pages. 4 maps. 25 illustrations. 8¼-in. × 5½-in.

(T. Fisher Unwin. Price 5/- net.)

In these days it is being abundantly recognised that the study of history and geography should begin at home, and it is quite obvious that those who are attracted by their natural environment will turn first to what is nearest at hand. To those who are not aware of the interest which can be found even in a London suburb which is blessed by the possession of open spaces, this account of Wimbledon Common will come as a surprise; and we may confidently say that every person who claims to be intellectual, and who lives in the neighbourhood, should read the book, while it should serve as an example and an encouragement to dwellers in other neighbourhoods to collect material for similar and equally valuable compilations.

ORNITHOLOGY.

A Hand-List of British Birds with an account of the Distribution of each species in the British Isles and Abroad.—By ERNST HARTERT, F. C. R. JOURDAIN, N. F. TICEHURST and H. F. WITHERBY. xii. and 237 pages. 8¼-in. × 5¼-in.

(Witherby & Co. Price 7/6 net.)

This work is certain to prove most useful to ornithologists, supplying, as it does, in one volume of moderate size and in concise terms, a mass of detailed information only available hitherto in various separate publications. It may well rank as the British ornithologist's vade-mecum: for ourselves we have found that, in the short time it has been in our hands, it has already secured a place of preference as a source of reliable information, and that we are continually referring to it. The title indicates the ground covered, and in addition notes are given on the migration of some species. As regards distribution, this is given with considerable detail for each of the three countries of the United Kingdom separately, and frequently for smaller geographical divisions, and this arduous and laborious task has been accomplished with completeness and success. The distribution abroad is also briefly given. It is rather to be regretted, however, that, in aiming at conciseness of language, telegraphese English is used, sometimes to the extent of obscuring the meaning of the sentence. An admirable brevity would still have been preserved had the authors allowed themselves the conventional use of conjunctions and prepositions. The number of species on the British list steadily increases and the present work admits four hundred and sixty-nine, as compared with Howard Saunders' "List" (1907) which has four hundred and fifteen, excluding doubtful records. We think that a brief analysis and summary into groups, such as resident birds, summer visitants and otherwise would have been instructive as bringing out one of the striking characteristics of our avi-fauna.

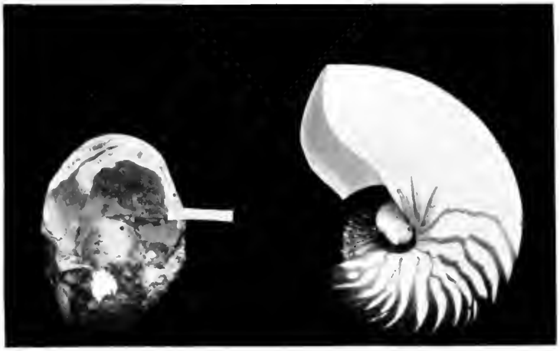
The distributional portion of the book is, we are sure, what the working ornithologist will most value, but it should be said that the authors seem to consider nomenclature to be of equal, if not greater, importance. They have certainly had the courage to place a heavy handicap on the acceptability of their work, by the sweeping and radical character of the changes made in the scientific names. Many of the bibliographical and critical notes elucidating this part of the work are of great interest, but the system which imposes such names as *Troglodytes troglodytes troglodytes* (L.) on the Wren (and there are many other similar names), has taken upon its shoulders a very heavy burden indeed,—even although it is based upon pure reason. Appearances are against it.

H. B. W.

THE PEARLY NAUTILUS: SOME HOMOLOGIES BETWEEN FOSSIL AND LIVING FORMS.

By A. R. HORWOOD.

It is well-known that the Pearly Nautilus* is the single living survivor (generically) of a once numerous and diverse group of Cephalopods which commenced with a prototype, possibly like *Tentaculites*, having a straight shell. Moreover, it has been established that the race evolved from a straight shell such as *Orthoceras* (see Figure 399), a type having a slightly-curved shell like *Cyrtoceras* (see Figure 400); and that in course of time this was again succeeded by a loosely-coiled form which had a spiral shell in which the whorls were not in contact, like *Gyroceras* (see Figure 401). Finally, there was a type in which the shell was closely-coiled, and in which later whorls overlapped the earlier ones, and of such a type was the early Nautilus (see Figure 402), whose descendants inhabit the Indian and Pacific Oceans to-day in pelagic depths. Such, briefly, is the course of phylogeny or race-history amongst the tetrabranchiate types of Cephalopods, and it is due to the researches of many palaeontologists that we now know that the life-history of a Cephalopod is a repetition of that of the earlier race-groups.



A B

From a photograph *by A. Newton.*

FIGURE 398.

A. Liassic *Nautilus striatus* J. de C. Sow., showing "black layer" and annular lobe.

B. Young Shell of living *Nautilus pompilius* L. showing "black layer" (lateral view).

No one contributed more towards the establishment of this great principle than the late Professor Alpheus Hyatt. He showed, amongst other things, that in the early stages of Nautilus it went through a *Cyrtoceras*-like stage (see Figure 400), when the shell was in shape like a ram's horn, uncoiled; and this stage was only the successor to a previous straight stage in which the protoconch was straight, and in line with the first chamber. But unfortunately this protoconch is only revealed in living as well as fossil forms by the scar left by its junction with the first or initial chamber; for the protoconch itself, possibly membranous, has disappeared.

Many other facts have been elicited by a study of the fossil Cephalopoda which all tend to corroborate this broad principle of the recapitulation of race characters by the individual, which support in a very convincing and empirical manner the still wider and more general principle of progressive evolution. That there has been retrogression, too, this very group, the Cephalopoda, bears out in a remarkable degree, not only in the senile stages acquired by the individuals in both two- and four-gilled groups, but also in the race-history, where the former became exceedingly abnormal, retrogressive, and finally extinct, in cretaceous times.

With this in view it is not remarkable that both fossil and living forms are found to exhibit in an extraordinary manner very perfect homologies between the organs adapted for any particular function in past and present times, and in the effects of their action. And no group of Cephalopods exhibits this characteristic more markedly than the Nautiloids; for in a considerable number of cases the means by which the animal was attached to the shell by shell-muscles in the last or living-chamber, and the marks left upon the shell-wall by the muscular impressions, was almost exactly identical in past times (as in the Jurassic period) as to-day.

And when we consider the extremely specialized nature of the habitat of the Pearly Nautilus—more or less deep-sea conditions, where little or no variation in depth, light, warmth, currents, or composition of the water could be effected—it is intelligible that the mode of attachment and similar characteristics of this interesting species should remain practically the same throughout a vast lapse of time. For it is

* There are four living species.

quite fully established that the effect of external conditions, once rather underestimated, has a distinct influence upon the course and nature of evolution. That the Ammonites had similar modes of attachment of the animal to the shell is abundantly illustrated by the testimony of numerous specimens exhibiting the same characteristic.

The composition and structure of the shell in Nautilus and its early ancestors has also remained remarkably uniform. Thus, in the fossil forms we find the shell consisting of two layers, an internal nacreous iridescent layer formed internally, and an external thicker layer formed by the mantle edges, whilst in addition to these, which are superposed in an imbricate manner like tiles, there was a "black layer," which was formed externally by the hood, representing the animal matter which was secreted by that organ. The same "black layer" is found within a double wall on either side of the inner and outer layers in the earlier parts of the shell before the last septum, as seen in the diagram. It occurs outside only in the volute part of the shell because there the wall is not duplicated as it is where the walls of newer and older chambers were in contact. The presence of this "black layer" between the two other layers placed on either side is demonstrated by the decalcification of a portion in acid, when there remains a certain quantity of organic matter representing the former "black layer." And the formation of shells is now held to be due to excretion and formed by the mantle or arms of the animal, by the building up of carbonate of lime upon a membrane of organic matter of a chitinous nature. This is the condition of the "black layer." The periostracum of many bivalves and univalves is formed by the mantle, and is the first-formed part of the shell, the calcareous part and coloured layer being deposited next; but, unlike the "black layer," the periostracum is only a protection, and a make-shift as it were, and not a permanent part of the shell, not being absorbed into the interior in a coiled species but eventually disappearing. The operculum of some species is deposited by the foot, and is not homologous with the last or the "black layer."

Figure 399.
Straight-shelled Cephalopod, *Orthoceras* type (reduced).

Figure 400.
Curved-shelled Cephalopod, *Cyrtoceras* type (reduced).

It is a point of some interest that the "black layer" which forms the inner dividing layer of two contiguous, but opposite, shell-walls, should be preserved in fossil forms of Nautilus in as perfect a manner as that which is seen so clearly in living examples of the Pearly Nautilus.

This is well-illustrated in the accompanying photograph of the Liassic *Nautilus striatus* Sow. (see Figure 398 A), and a young example of the living Pearly Nautilus. In young forms of the latter the deposit is a shiny black opaque layer which is remarkably smooth and jet-like. But in older examples there are numerous plicae or folds coinciding with the gradual encroachment of the hood upon the coloured shell surface, which is the ventral surface continued, and lies next to the dorsal lobe of the hood which would be against the dorsal side of the shell if it were continued beyond the last septum, which is not the case. These plicae are reproduced in the fossil form. Upon the surface also may be observed both in the recent Nautilus and in this Liassic species, numerous excrescences, which represent the papillae on the hood. Such a remarkable resemblance between species so remote in relationship is truly extraordinary.

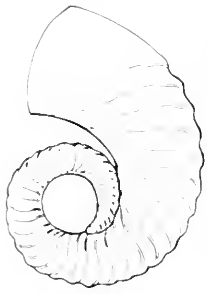


Figure 401.
Loosely-coiled Cephalopod, *Gyroceras* type (reduced).

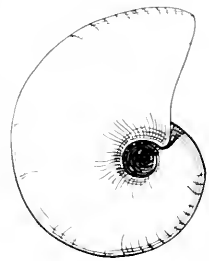


Figure 402.
Closely-coiled Cephalopod, *Nautilus* type (reduced).

But in these two specimens again we have a further interesting feature, for in the Liassic species below the central siphuncular impression is a similar, but depressed, ring-like marking, which represents the annular or median dorsal lobe. It is not often to be detected in the last septum of *Nautilus pompilius* (see Figure 398 B), but is represented in earlier septa, and in some young forms by the little pit-like hollow here seen in *Nautilus striatus*.

Figure 403.
Section through an early stage *Nautilus* to show central black layer (enlarged).

The occurrence of two similar features in the Liassic and present-day Nautilus is interesting, as it indicates the presence in both of an annular muscle. No figure of the "black layer" in a fossil species has hitherto appeared.

TO FIND THE DAY OF THE WEEK.

By JAMES ASHER.

Four new methods of finding the day of the week in any year, when the corresponding date in some other year is given, have been recently devised by the writer. These will presently be described.

Before these methods can be used it is desirable to know how to tell whether a year is leap year, also to tell how many leap days are between a date in a given year and the corresponding date in any other given year. The writer has also devised new methods for these.

A year is leap year if the number expressed by the last two figures is a multiple of 4. Thus 1908 was leap year for 08 is a multiple of 4. The year 1927 will not be leap year, for 27 is not a multiple of 4. On dividing 27 by 4, the remainder shows that 1927 will be the third after leap year.

Since 1752, centennial years not divisible by 400 are not leap years. Thus 1800 and 1900 were not, but 2,000 and 2,400 will be leap years. The centennial years before 1752 were all leap years from the time of Julius Caesar.

It was decreed that, in England and its colonies, the day after September 2nd, 1752, should be called the fourteenth. It was also decreed that, thereafter, of the centennial years, only those which were multiples of 400 should be leap years. Further, it was ordered that the year should begin on January 1st, instead of March 25th.

To find the number of leap days between a given date in one year and the corresponding date in another:

Find the number of years from first February 29th, after the date in first year to the first February 29th, after the date in the last year, and divide by 4. If any centennial years, after 1752, not multiples of 400, intervene between the first February 29th, after the date in the first year and the first February 29th after the date in the last year, subtract one for each, after making the simple calculation.

But, when the first and the last year are both leap years, it is better to subtract the first from the last, and divide by 4. If any centennial years since 1752, not multiples of 400, intervene between the first and the last year, subtract one for each, after performing the division.

If the day of the month in the first year of the period is on or before September 2nd, 1752, and the last year is after 1752, do not use the same day of the month in the last year, but use a date 11 days later, in making calculations according to the methods to be presently described.

First problem, first method:—

Magna Charta was signed by King John and the barons, June 15th, 1215.

Find the day of the week, knowing that June 26th, 1912, was Wednesday.

Solution:—

The period is 697 years. From February 29th, 1216, to February 29th, 1916, are 700 years. The fourth of 700 is 175. We subtract 2 from this because 1800 and 1900 were not leap years. Thus we find that there were 173 leap days.

In the 697 tropical years from June 15th, 1215, to June 26th, 1912, there are

$697 \times 365 + 173 = 254.578$ days, or 36,368 weeks and 2 days.

When the number of weeks is a whole number, in other words when no days remain, the day of the week required is, evidently, the same as the given day of the week. In solving the problem we have found 2 for remainder. This shows that the required day of the week is two days farther back than our given day of the week. Now the given day is Wednesday. Count backward 2 days to Monday, the answer.

In solving problems by any of the methods described in this article, if the given day of the week is in the first year, in using the remainder, count forward.

Second problem, by a second method:—

Christopher Columbus discovered America, October 12th, 1492. Find the day of the week, knowing that October 23rd, 1912, will be Wednesday.

Solution:—

The period is 420 years. The first and last year are leap years. The fourth of 420 is 105. We subtract 2 from this, because 1800 and 1900 were not leap years. We thus find that there were 103 leap days in the period.

In the 420 years there were $420 \times 365 + 103$ days.

It will be seen that 420 is a multiple of 7, consequently 420×365 days is a whole number of weeks, and we need do nothing with 420 and 365. Divide 103 by 7 and find 5, the remainder. Count backward 5 days to Friday, the answer.

This method can be used only when the number of years is a multiple of 7.

Third problem, by a third method:—

Queen Victoria was married February 10th, 1840. Find the day of the week, knowing that February 10th, 1891, was Tuesday.

Solution:—

The period is 51 years. The first February 29th after February 10th, 1840, was February 29th, 1840. The first February 29th after February 10th, 1891, was February 29th, 1892. From February 29th, 1840, to February 29th, 1892, were 52 years. The number of leap days is found by dividing 52 by 4. We thus find that there were 13 leap days between February 10th, 1840, and February 10th, 1891.

In the 51 years there were $51 \times 364 + 51 + 13$ days.

The number 7 is a factor of 364, therefore 51×364 days is a whole number of weeks, and nothing need be done with it. Divide the sum of 51 and 13 by 7, and find that 1 is the remainder. Count backward one day from Tuesday to Monday, the answer.

Our proceeding may be set down as a rule thus: Call the number of years in the period, days; to this add the number of leap days in the period, then divide by 7. Count backward from the given day of the week as many days as there are in the remainder. But if the first date is on the given day of the week, count forward.

Fourth problem, by the third method:

Standard time was adopted, in the greater part of North America, November 18th, 1883. Find the day of the week, knowing that November 18th, 1912, will be Monday.

Solution:

The period is 29 years. The number of years from February 29th, 1884 to February 29th, 1916, is 32. The fourth part is 8. Subtract 1 because 1900 was not leap year. We thus find that there were 7 leap days.

We may omit some of the figures that were shown in solving a problem by the third method. We add together a number of days equal to the number of years in our period, and the number of leap days, then divide by 7. Now the sum of 29 and 7, divided by 7, gives 1 for remainder. Count backward 1, from Monday to Sunday, the answer.

Fifth problem, by a fourth method:—

Charles Robert Darwin and Abraham Lincoln were born on the same day February, 12th, 1809. Find on what day of the week was the hundredth anniversary of their births, knowing that February 12th, 1912, was Monday.

Solution:—

The days of the week seem to step ahead one day each year as you go forward, and to step backward one day if you go backward in reading. In leap year, after leap day, the day of the week will be found two days ahead of the day on the corresponding date in the previous year.

In our problem the period is 3 years. There are no leap days, because our period ends before leap day, or February

29th, 1912. We count backward 3 days from Monday to Friday, answer.

This method can be readily used when the period is short.

Sixth problem, by third method:

The next transit of Venus will be on June 8th, 2004. Find the day of the week, knowing that June 8th, 1912, was Saturday.

Solution:

The period is 92 years. Both first and last are leap years. The number of leap days is one fourth of 92 or 23. The sum of 92 and 23 divided by 7 gives a remainder 3. Count *forward* 3 days from Saturday to Tuesday, the answer.

When it is required to know on what day of the week February 29th, either was or will be, find the day of the week for February 28th, of the same year, by one of the methods herein described, then count forward one day.

Seventh problem.

Find on what day of the week February 29th, 3992, will be knowing that February 28th, 1912, was Wednesday.

Solution:

The period is 2080 years. Both first and last are leap years. The fourth of 2080 is 520. The years 21, 22, 23, 25, 26, 27, 29, 30, 31, 33, 34, 35, 37, 38 and 3900 will not be leap years. There are 15 of these. Substract 15 from 520 and find that there will be 505 leap days. The sum of 2080 and 505 divided by 7 gives 2 for remainder. Count forward 2 days from Wednesday, and find that February 28th, *3992*, will be Friday. Of course, February 29th, *3992*, will be Saturday, the answer.

The third method is the best for general use.

Should the reader prefer, he may find the number of leap days between the two given dates by counting. For example, in the fourth problem, he can see that between November 18th, 1883, and November 18th, 1912, were the following leap days—February 29th, 1884, 1888, 1892, 1896, 1904, 1908 and 1912. There are 7 of these, as we have already found.

NOTICES.

THE DUNDEE MEETING OF THE BRITISH ASSOCIATION. The meeting of the British Association which opens under the general presidency of Professor Schafer at Dundee on September 4th, bids fair to be an excellent and an enjoyable one. The city, as we can speak from pleasurable experience, knows how to entertain its visitors right royally, and one feature of the meeting will be the large number of foreign guests. Judging, too, from the presidential addresses to the Association as a whole, and to the various sections, which we are privileged to read, but whose nature we are not permitted to reveal until they have been delivered, members old and new who go to Dundee will not regret having made the journey. In this connection we have pleasure in reproducing for the benefit of our readers a time table of the trains from Euston, which the London and North Western Railway has kindly forwarded to us.

Week-days.

		L.T	L.D	S	S sx
		a.m.	p.m.	p.m.	p.m.
LONDON (Euston) ...	dep.	10.5	2.0	8.0	11.45
		A			Ax
		p.m.	a.m.	a.m.	a.m.
DUNDEE (West Station)	arr.	8.50	1.15	6.45	9.52

Sundays.

		S		
		p.m.	p.m.	p.m.
LONDON (Euston) ...	dep.	8.0	8.50	11.45
		a.m.	a.m.	a.m.
DUNDEE (West Station)	arr.	6.45	9.37	9.52

NOTES:

L.T—Luncheon and Tea Cars.
L.D—Luncheon and Dining Cars.
S—Sleeping Cars attached.
S sx—Sleeping Cars attached, except Saturday Nights.
A—Through Carriages to Dundee.
Ax—Through Carriages to Dundee, except Saturday Nights.

Charge for sleeping berth 10s. in addition to first class fare.

HOUSE FLIES. Of recent years the harm which house flies may do in the carrying of infection has been emphasised. Some very careful experiments, which are described by Dr. Graham-Smith in the current number of *Bedrock*, give a clear idea as to how long after contamination the germs of disease flies may continue to be dangerous. The typhoid bacillus may remain alive in the intestines of the flies for at least six days and flies can infect materials over which they walk for at least two days. Bacilli which produce the symptoms of meat poisoning behave in the same way. Tubercle bacilli can be found in the intestines of flies ten days or more after infection. In the case of germs which produce spores that can only be killed with great difficulty, these may remain on the dead fly for months or even years. It was also shown that flies which feed on milk, or which tumble into it, are capable of infecting it, and although under ordinary conditions in this country the adult fly seldom has the opportunity of feeding on materials infected with disease-producing bacteria, yet the maggots are often probably infected. Further researches are being made into the question whether the flies which spring from these would also be infected, and we await the results with much interest.

CLASSES IN PHOTOGRAPHY.—We have pleasure in announcing that Mr. Edgar Senior's classes in Photography for the autumn session will open at the following Polytechnics on the dates specified: Battersea, Tuesday, October 1st; South Western, Monday, September 23rd; and Woolwich, Wednesday, September 25th, 1912.

THE OPTICAL CONVENTION, 1912.—With further reference to new apparatus exhibited at the Optical Convention ("KNOWLEDGE," August, 1912, page 291) we may refer to that shown by Messrs. Newton & Co. Special mention should be made of Cheshire's Optical Apparatus, never before exhibited in the complete form in which it was shown at work during the Convention. It consists of an optical bench which can be mounted in the form of a Projection Spectroscope, Polariscope or any similar apparatus. The Colour Projection portion is probably the best method of showing the composition of white light at present devised, and consists of recomposing the spectrum on the screen by means of a convex lens. In the spectrum itself is then placed a number of wedge prisms cut slant-wise, which reflect portions of the recomposed beam upwards and outwards so as to give a number of overlapping colour discs. These discs change their tints as the wedge prisms are moved along the spectrum, but they are always complementary, and the overlapping portion in the centre is always white.

Another development of the same apparatus is the Model Eye, also arranged for projection on the screen, the picture of the retina itself being projected and the various defects due to presbyopia, myopia and astigmatism demonstrated.

Another instrument shown was a cheap three and a half inch astronomical telescope, of great optical perfection, on a simple yet strong altazimuth stand. In addition to these there was a full range of the firm's well known optical apparatus.

WHAT DETERMINES SEX.—To *Scientia* for May, Professor Arthur Thomson contributes a critical essay entitled, "What determines sex." He discusses five different theories, and concludes by giving his own view that the difference between an ovum-producer and a sperm-producer is fundamentally a difference in the balance of chemical changes, that is, in the ratio of anabolic and katabolic processes which may, of course, have its structural expression in the relation of nucleo-plasm and cytoplasm. In fact, he adheres to the thesis of his book, "The Evolution of Sex," that the sex-difference is one expression of a fundamental alternative in variation to be seen throughout the world of life.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

OCTOBER, 1912.

FURTHER REMARKS ON THE TRUE STRUCTURE OF THE DIATOM VALVE.

By T. F. SMITH.

(*Continued from page 356.*)

OUR knowledge of the secondary structure of diatoms may be said to date from a few years after the advent of the oil-immersion objective, more especially from the epoch-marking paper, already alluded to, read by Messrs. Nelson and Karop before the Quekett Club in 1886. The first oil immersions showed no improvement upon the water immersions, due to the splendid pitch to which these last had been brought in this country. In the interval, however, between 1878 and 1886, the N.A. of the oil-immersion had been worked up to 1·43 by Messrs. Powell and Lealand; Mr. Nelson became the owner of one, and hence the paper: "On the Finer Structure of certain Diatoms." In the introduction the authors say: "On examining certain Diatoms with the finest oil-immersion objectives, and under conditions of illumination such as are absolutely essential if the full aperture and, therefore, resolving power, of these glasses is to be utilised, some details of structure are brought into view which are otherwise quite invisible, and, so far as we know, have not hitherto been correctly described or properly figured. Acting on this belief, we have ventured to bring before your notice some short observations, accompanied by careful drawings, recently made on a few well-known forms."

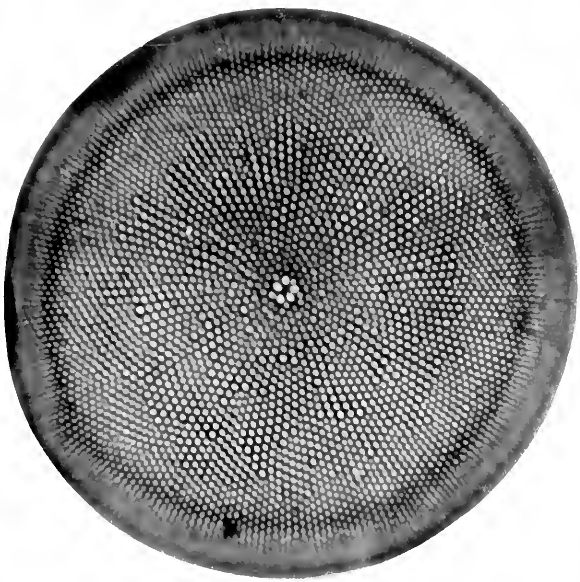


FIGURE 404. *Coscinodiscus asteromphalus.* Objective used, Swift and Son's one inch of 0·30 N.A., orthochromatic plate, no screen, magnification three hundred and fifty diameters, exposure ten minutes.

This was but the first of a splendid series of observations, continued by Mr. E. M. Nelson right down to the present time. Others, of course, have followed, and as Dr. Dallinger said in the last edition of Carpenter (1901): "The nature of the delicate markings with which almost every diatom frustule is beset has been one of the most interesting enquiries of the students of these forms since the introduction of the homogeneous, and especially the apochromatic, objectives: and it cannot be doubted that certain peculiarities of structure have been demonstrated which were never before seen." One is aware that this does not constitute the whole work of the microscope, or even the better part, yet it possesses this distinction that it has paved the way towards making other work possible. The President of the Royal Microscopical Society said on the reading of a recent paper on diatom structure, that: "The Society was always grateful for any work on diatoms, as this work had, more than any other, led to the perfecting of our microscopic lenses."

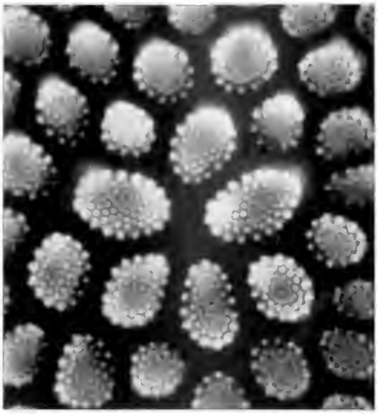


FIGURE 405. *Coscinodiscus asteromphalus*, centre, but from another valve. Objective used, Baker's oil immersion, one-twelfth inch of 1·30 N.A., ordinary plate, no screen, magnification two thousand seven hundred and fifty diameters, exposure twelve minutes.

Recurring to Messrs. Nelson and Karop's paper; occupying the centre of their plate is *Coscinodiscus asteromphalus*, of which it may certainly be said the finer structure had never been seen nor figured before. More, indeed, than *T. favus* the visibility of the finer details upon this form is due entirely to the oil-immersion objective, being beyond the compass of a dry lens. The general form and appearance of this diatom under an apochromatic twenty-four millimetre of Zeiss is given in Plate 1 of the Dallinger "Carpenter," and in the same plate a photomicrograph of a portion of the valve at two thousand diameters. Both are by Mr. E. M. Nelson. It may seem rash of the present writer to attempt to follow in the footsteps of so splendid a manipulator. Perhaps he would not, had it not been to prove a point—the identity of structure in all diatoms. This form also is well to the front, much discussed, just now, when it is as well to be in the fashion.

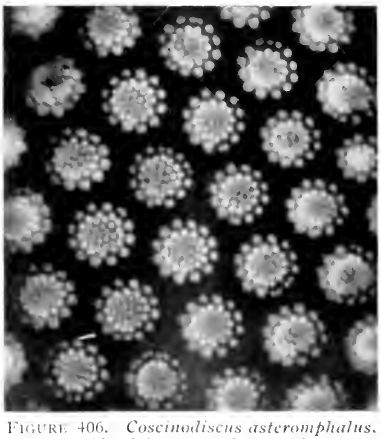


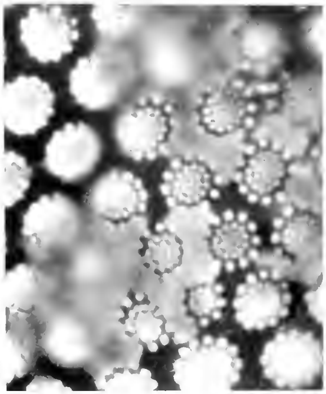
FIGURE 406. *Coscinodiscus asteromphalus*. From the side of the same valve as Figure 404. Objective, Baker's one-twelfth inch oil-immersion, ordinary plate, pot green screen, magnification two thousand seven hundred and fifty diameters, exposure three hours.

It will be seen that the rendering here differs from Mr. Nelson's, though it is in accordance with Dr. T. W. Butcher's, in his paper published in *The Journal of the Royal Microscopical Society* for December last, Mr. Nelson always went for the black dot as being the most truthful; the present writer prefers the white as being the most pretty. As for truth, he does not believe that there is a pin's difference to choose between the two.

Into the merits of the controversy between these authorities it is not proposed to enter here. The writer's own experience has been unfortunate in this matter. Wishing to find out for himself, and seeing a slide advertised as being prepared to show Mr. Nelson's tertiary structure, he bought one, only to be confronted with a vision of eye-spots. They were upon forms so small, too, that it would have been difficult to make out the secondary structure even had they been the right way up. His own knowledge, therefore, upon this point still remains in abeyance.

Figure 404, showing the whole disc, is taken by a one inch of Swift & Son, of 0·30 N.A., magnified three hundred and fifty diameters. Mr. Nelson's is under dark ground illumination, so in this case there are no points of comparison. Figures 405 and 406 show the normal aspect with white dot focus of parts of the valve under an oil-immersion, magnified two thousand seven hundred and fifty diameters. Dr. Butcher has so accustomed us to heroic magnifications that one is bound to follow his example, if only to compare results. Yet one remembers the time when one thousand diameters was looked upon as the efficient maximum. Yet the lenses were the same as now; further, nothing so far has been seen under the microscope which cannot be readily made out with this power. The white dot in Figure 405 must be taken with a qualification. It is really half white and half black dot, due to the whole of the field not being in quite the same plane. One other point besides it does show, however: how beautifully the objective was in adjustment under the tube-length employed.

The next two Figures, 407 and 408, present examples of torn structure in this diatom. We have in this form the same structureless membrane, stretched upon the top to cover the sides of the hexagonal framework, as in *T. favus*. In Figure 407 it is seen spanning a gap, and half-way across one of the characteristic circles of white spots. Note, also, the outer sides of the rings where the membrane is torn away, and see how exactly they agree, both in this and in Figure 408, with similar structure shown in Figures 392, 393, 395, 396, and 397. Can anyone doubt, also, that in Figure 405 we see the same disposition of structure as in Figure 3?



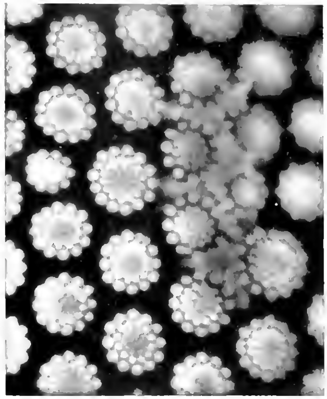


FIGURE 407. *Coscinodiscus asteromphalus.* Torn structure from another valve. Objective, Baker's oil-immersion, ordinary plate, no screen, magnification two thousand seven hundred and fifty diameters, exposure twelve minutes.

FIGURE 408. From the same valve as Figure 407.

In the torn structure of *T. favus*, the writer thinks, lies the key to secondary structure generally. One admits that when we come to the finer it must be more from analogy than from direct proof. If, on the other hand, we reject the inference we are met with this difficulty. The general lines upon which the compound triangular and discoid forms are constructed are the same. The hexagonal framework and the under layer of eye-spots can be demonstrated by direct proof — is analogy to stop short at this point because the finer structure at the top, though seen, cannot be so dealt with? When any detail of structure is no longer within the grasp of the aperture of the objective, it is only imperfectly resolved. Dr. Abbe, moreover, has told us in his paper, "On the relation of aperture to power," that under these conditions, all such details, whether triangular, square or lozenge shaped, assume the same rounded or oval outlines. In *P. formosum*, for instance, the "heads" were always spoken of as round, yet under the 1·40 apochromatic in the writer's print of the broken valve with the postage-stamp fracture they come out distinctly square.

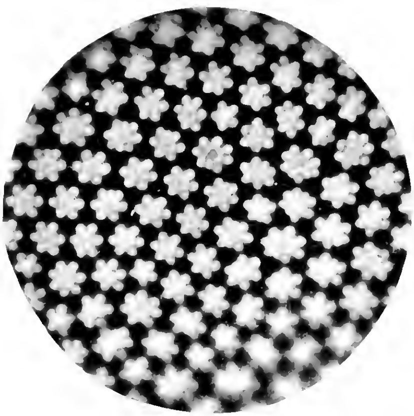


FIGURE 409. *Coscinodiscus centralis.* Objective, Baker's oil-immersion, ordinary plate, pot green screen, magnification two thousand seven hundred and fifty diameters, exposure three hours.

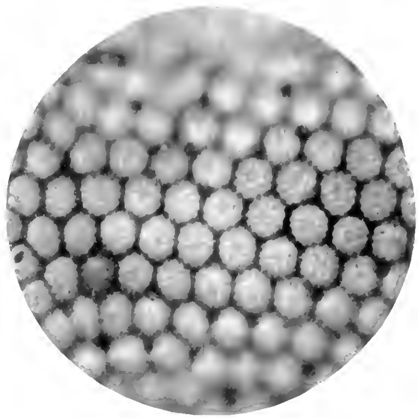


FIGURE 410. *Aulacodiscus Kittonii.* Objective, Swift & Son's one-twelfth inch oil immersion of 1·30 N.A., orthochromatic plate, yellow screen, magnification one thousand nine hundred diameters, exposure twenty minutes.

Figure 409 is another specimen of the discoid form, *Coscinodiscus centralis*, where we seem to arrive at the region of imperfect resolution: that is, in the finer detail. The structureless covering over the hexagons is here arranged in a symmetrical pattern, reminding one of a tesselated pavement. Interspersed are the somewhat irregular patches of bright dots, well defined as to the outer ones, but running together and indistinct in the centres. An aperture of 1·40 would render them plainer, but even then some specimens defy resolution altogether.

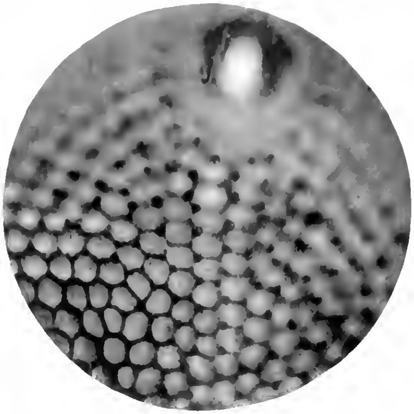


FIGURE 411. *Aulacodiscus Kittonii*, from another valve. Objective plate and screen the same, magnification two thousand seven hundred and fifty diameters, exposure half an hour.

Another and interesting form just on the borderland of resolution by an oil-immersion is *Aulacodiscus Kittonii*, a very difficult object to photograph, because of the inequalities of the surface, and a striking picture is impossible. There is a figure of this diatom in Plate 1 of Dallinger's "Carpenter," taken by Mr. Nelson with a low power. A drawing also of the finer structure accompanies a second communication to the Quekett Club by Messrs. Nelson and Karop, in 1887. There seem to be no published photographs of the finer structure, but an attempt is now made in Figure 410 to supply this deficiency, taken at one thousand nine hundred diameters. Only over a small part of the picture are the areolations in focus, and not good even at that. It should prove interesting, however, as presenting the general character of this form, though it cannot be produced upon the same plane. At the corners of the hexagons are stuck little bosses, slightly projecting, seen mostly at the right hand side of the print and at the top. Above all appears one of the processes (there are four in *A. Kittonii*) characteristic of this genus.

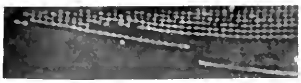


FIGURE 412. Fibrils of *Pleurosigma formosum*. × 1750.

FIGURE 413. Fibrils of *P. balticum*. × 1750.

Figure 411 is from the fragment of another valve, with smaller cellules but rather bolder areolations, taken at two thousand seven hundred and fifty diameters. No attempt is made here to include the bosses, though a few are indicated, as black spots, where the object is out of focus. At the top of the valve (not shown here) the surface is ruptured, producing a crack, and one of the broken edges shows the same zig-zag appearance, which may be said to be produced by a fibril. The evidence is positive which we could scarcely have expected to find amongst such fine structure. In another part of the valve the hexagons are torn away, leaving the rings of minute areolations projecting over the gap, as in Figures 407 and 408 of the much coarser details. One might, indeed, in some of these forms map out the spaces and produce an atlas. One might, indeed, go on to infinity producing examples, were it not that space, and the editors, forbid. The Figures 412–417 shew a number of fibrils taken from different diatoms of various size and contour.

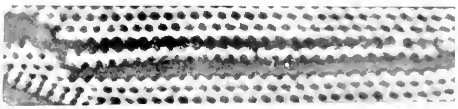


FIGURE 414. *P. angulatum*. × 3770.

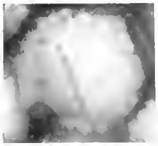


FIGURE 415. Single fibril of *T. favus*. × 3000.

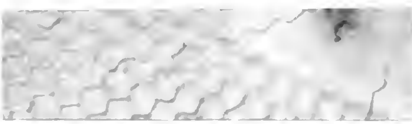


FIGURE 416. Fibrils of hexagons of small *Coscinodiscus* unravelling. × 3500.

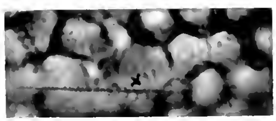


FIGURE 417. Fibril of *Aulacodiscus Kittonii*. × 2750.

And here the writer thinks it is time to stop, saving his breath for a future occasion—perhaps?

ON STELLAR AND NEBULAR DISTANCES.

By PROFESSOR FRANK W. VERY.

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(*Continued from page 332.*)

AMONG the possible modes of origin of a galaxy, we have the clashing of interpenetrating streams of matter moving in different directions. Within the region of intersection kinetic energy is more or less completely destroyed and converted into heat through collision and friction. Equal streams of meteorites moving in opposite directions are probably capable of producing in this way a fixed focus of most intense heat which perhaps might develop into a galaxy; or if the meteoritic swarms were unequal, or met at an acute angle, a resultant motion would continue in the composite aggregation. The first stars should be nearly devoid of local motion.

The dimensions of a galaxy may result in part from the size of the section of the original colliding meteor streams, and partly from the intensity of the perturbations (both astronomical and physical) which are engendered by the clash. Eventually, the meteoritic streams will come to an end, and the fiery rain of colliding particles will cease, making way for the interaction and further evolution of intensely heated bodies, born from the coalescence of the interacting masses. We have reason to believe that the Orion-type stars represent some of these early stages of stellar development.

It is now known that the galactic helium stars have not only small proper motions, but very small linear velocities in the line of sight. If we assume that they have developed recently from masses of matter in which kinetic energy has been largely annulled in the production of thermal energy, their slow motion is explained. Being too far apart and too uniformly distributed to acquire marked individual acceleration in definite directions, they may nevertheless continue to drift along in the residual direction which is proper to the swarm. Rancken, in 1882,* by considering proper motions of star-groups associated with the Milky Way, found evidence of a star-drift along the course of the stream. The research requires the segregation and separate investigation of special groups which are inextricably entangled and lost by indiscriminate methods of averaging. Rancken's research was confined to stars within 30° of the galactic plane, and the drift along the Milky Way appears to affect stars of the Sirian type principally; but these stars are only a little more advanced than stars of the Orion type. They move a little faster than the helium stars, and would barely show sensible proper motions at a distance of one hundred light-years. Like the Orion stars they might be suitable for disclosing the reflected solar motion.

In assuming an approximate diameter of one hundred and twenty light-years for the Galaxy, my purpose being to institute a comparison with the nebulae, it was expressly stated that only the brighter central regions were considered, for the reason that the less luminous parts are unlikely to be observed in very faint nebulae. It was to be presumed that the outer boundaries of the Galaxy, in its diffusely scattered borders, are much more distant than sixty light-years (in fact, I suggested for this outer limit a distance ten times as great); but regarding the brighter portions of the Milky Way as segments of slightly eccentric arcs of spirals along which myriads of stars are grouped in very much closer array than in our own portion of the great aggregation, the distance assigned to the nearest region of condensation is derived on the following suppositions: (1) That the novae, as a rule, are situated in the crowded spaces of the Milky Way; (2) that Nova Persei (1901) was one of these typical novae; (3) that it is not possible for matter to move with a greater velocity than that of light: whence it follows from the most rapid expansion of some parts of the nebulosity which appeared temporarily around this star, that its distance and that of the associated galactic stream, cannot be over sixty light-years.

There have been suggestions that the expansion of the nebulosity around Nova Persei may have been due to the motion of gaseous molecules driven off by light-pressure from the excessive intensity of luminosity at the maximum outburst of light; but in this case no one supposes that the velocity can have been at all comparable with that of light, and it follows that the star ought to be very near to us. This hypothesis, however, cannot be maintained, because measurements of the star's parallax reject the supposition. Professor Newcomb is the only astronomer of note who has contended that this marvellous occurrence bears witness to the existence in nature of velocities, in material particles, which are *greater* than that of light. By so doing, Newcomb opposed the unanimous opinion of physicists, basing his opposition, presumably, upon an exaggerated estimate of the accuracy of parallactic measures.

One other suggestion remains: which is, that the moving particles were positive ions electrically discharged. These may reach velocities of a high

* *Astronomische Nachrichten*, No. 2482.

order, even approaching that of light; and these discharges concerned particles whose masses were in the ratio 1 : 2 : 4, and thus explain a very remarkable feature of multiple emanations at these distances. For this reason it appears to me probable that this was the real nature of the phenomenon.[*]

When we recognize that stars which are at the same distance vary enormously in luminosity, we have to admit that, unless the object selected happens to be very near, the method of measuring relative parallaxes by comparing positions of neighbouring stars viewed from the ends of a radius of the Earth's orbit, and selecting faint comparison stars on the plea that they are probably farther away, is very unsatisfactory. The parallaxes of a few hundredths of a second obtained in this way are often fictitious. Even negative parallaxes may be found, showing that the faint stars were really the nearer. In spite of the great accuracy of instruments and observers, the means for discriminating between the objects selected remain insufficient. Hence it has seemed to me wiser to accept such an indication as has been furnished by the outburst of nebulosity around Nova Persei, rather than to trust to large numbers of apparent parallaxes of a few hundredths of a second, which are affected by the unknown parallaxes of the comparison stars.

Of twenty-eight stars between the fourth and tenth magnitudes, with annual proper motions ranging between 0″·01 and 3″·75, three which had proper motions of 0″·01, but which were among the brightest stars on the list (magnitudes 3·8 to 4·7), all gave to Dr. Schlesinger negative parallaxes large enough to show that they were more distant than the comparison stars.[†] The following are the mean parallaxes:

4th magnitude	(2 stars)	...	...	π	−0″·002
5th	,, (4 stars)	...	...		+0 ·045
8th	,, (10 stars)	...	...		+0 ·085
9th	,, (8 stars)	...	...		+0 ·145
10th	,, (2 stars)	...	...		+0 ·173

Most of these stars were selected on account of their large proper motions, but the four brightest ones were chosen to give examples of the Orion type. The series is interesting because it relates to fainter stars than are usually picked out for parallactic measurement, and because, like Eastman's list of proper motions cited above, it does not show any falling off with diminishing brightness. That a fourth-magnitude star of small proper motion may be farther away than a ninth-magnitude star of large proper motion, is a result which justifies the use of large proper motion, rather than that of brightness, as a criterion of nearness; but the phenomenon of star-drift suggests that proper motion, in turn, may fail as a test, especially for stars belonging to an assemblage which shares with our Sun in a common motion through space.

If the Sun were removed until it appeared as a seventh-magnitude star, it would still be three times as distant as the mean of the ninth-magnitude stars measured by Dr. Schlesinger. We are not making any large demand on probability if we assume that a particular strand of the Milky Way consists of seventh to fifteenth-magnitude stars no farther away than our hypothetical seventh-magnitude Sun, all moving in the same general direction and having neither recognizable parallax nor proper motion. If the Sun shares the motion only in part, a small stream-drift, such as is indicated by Rancken's investigation, remains.

An annulus has been assumed as a first approximation to the galactic shape by most investigators, because we have no means of differentiating between this shape and the more general two-branched nebular spiral, since the more remote turns of the spiral are superposed and projected on the same great circle of the sphere. The opposition of two narrower and brighter parts of the Galaxy, together with a similar opposition of the more widely diffused parts of the ring at points 180° apart, indicate that the Milky Way is really a two-branched spiral. If the Sun, instead of being in the central lumen of an annulus, is situated between two branches of a spiral, or as shown in Figure 359, the total breadth of the spiral figure may easily be five times the diameter of a simple ring, or the radius of the outer boundary of a circular disc may be five times the distance from the Sun to the nearer condensations; and some such unknown factor is implicitly understood in an estimate which purports to give only the order of magnitude involved. But if the linear dimensions are increased five-fold, the assumed luminosity of Nova Andromedae must be twenty-five times greater. This is perhaps not beyond the bounds of possibility; but to increase the distances fifty-fold, as Dr. Crommelin would have us do, increasing the brightness of the nova in the ratio 2,500 : 1, puts a strain on the probable luminosity of even such a remarkable object as a nova, because my estimate had already assigned to this star the status of one of the brightest of the novae. This dilemma was also instanced by Gore[‡] as an argument against the ascription of so large a distance to the Andromeda nebula, and it has seemed to me conclusive.

If the Galaxy is a unit with two great branches which are the relics of the original movements, then two great opposing drifts, modified by minor local drifts, ought to surpass all others. The hypothesis hitherto accepted is thus stated by Newcomb[§]: (Supposition *a*) "There are scattered around us in the stellar spaces, in every direction from us, a large

[*] Frank W. Very, "An Inquiry into the cause of the Nebulosity around Nova Persei." *Am. Journal of Sci.* (4) Vol. XVI, page 49, July, 1903.

[†] Frank Schlesinger, "Photographic Determinations of Stellar Parallax made with the Yerkes Refractor." *Astrophysical Journal*, Vol. XXXIV, page 26, July, 1911.

[‡] "KNOWLEDGE," July, 1909.

[§] "The Stars," page 293.

number of stars, each moving onward in a straight line and in a direction which, with rare exceptions, has nothing in common with the motion of any other star."

Suppose that we substitute for this the following statement: (Supposition *b*) There exist scattered through space, in every direction, millions of stellar aggregations, each of which is a galaxy. Each galaxy is composed of many millions of stars moving for the most part in definite star-streams with velocities which increase with their age. As viewed from a given point within our Galaxy, the motions of the nearer stars may be grouped in a small number of prevalent drifts which may be under the gravitational control of great central masses, or highly-condensed clusters of stars, but the local drifts do not necessarily coincide with the main drifts of the dominant streams.

This supposition puts a very different interpretation on the facts of observation, and may reconcile difficulties which seem, at first sight, almost insuperable.

Newcomb gives in his work on "The Stars" a very accurate analysis of probabilities as applied to the nearer stars on supposition *a*. If we replace this criterion by supposition *b*, we have a less rigid rule, and some of the former conclusions are abrogated, or can be explained differently. For example, the percentage of negative apical motions, derived from the Bradley-Auwers stars, is found to increase as the cross-motion diminishes. Newcomb concluded that "this arises from the fact that in the case of the nearer stars the apical motions are necessarily larger, whether positive or negative." If, however, we suppose that not much beyond the general sphere of the nearer stars there are great star-streams moving nearly parallel to the Sun's way, there ought to be a large increase of negative apical motions on approaching the confines of the streams, together with a cessation of cross-motion.

The determination of the general motions of the Galaxy requires a knowledge of the trend of myriads of stars composing its major streams. The movements of a few stars, or even of a few thousand stars in several local clusters, or subordinate streams, are obviously inadequate to characterize the grand trend of the formation as a whole; but the greater the number of available stars the nearer we shall come to the ideal, especially if the phenomena of star-drift are studied. Professor Boss has made a slight move in this direction. In his first paper on "Precession and Solar Motion,"[3] he says of certain "closely accordant proper-motions: Each of these was condensed into one mean star representing the whole, except in the case of the moving cluster in Taurus, where four stars taken at random were employed as representative of the entire forty-one stars therein." To be entirely consistent, he should have classified the remaining stars by drifts, substituting for each drift one, or at most a very few mean representative stars. This he has not done, but has preferred the ordinary hypothesis that the peculiar motions of the stars are at random. In this way he has reached the conclusion that the mean motion of three thousand five hundred and forty-nine stars of sixth magnitude, or brighter, having annual proper motions less than 0″·20, is $\mu_o = 0''\cdot0566$, and that the parallactic motion at 90° from the solar apex is $M = 0''\cdot0399$; while, for five hundred and fifty-nine stars having annual motions between 0″·17 and 0″·80, $\mu_o = 0''\cdot319$ and $M = 0''\cdot2158$. That the ratio μ_o/M is nearly the same in either case testifies to a similar distribution of the stars of either selection among the several drifts, but does not disprove the existence of diverse drifts. Consequently, the variation of average proper motion in the two groups presumably signifies a real variation in the mean distances in the proportion of six to one, which is another testimony to the great extent of the local drifts.

When Professor Boss grouped his grand total of five thousand four hundred and thirteen stars according to their galactic latitude, a very different result was obtained. The ratio μ_o/M was found to vary as follows:—

Galactic latitude	−7 to +7	+7 to +19 −7 ,, −19	+19 to +42 −19 ,, −42	> +42 > −42
μ_o/M	1·18	1·25	1·36	1·62

Here we have a demonstration that the motions of the lucid stars are in some way associated with the direction of the galactic plane. It may be that most of the stars are moving in planes parallel to the galactic plane, and that the stars in low galactic latitudes have their motions foreshortened, as Professor Boss suggests; or it may turn out that the actual linear velocities diminish as the Galaxy is approached; but the main point is that the Galaxy is not so far away as to be out of touch with these stars.

The transformation of the proper motions into linear velocities will depend upon the value attached to measures of parallax, and thus upon the computer's point of view. The value of the mean motion for three thousand five hundred and forty-nine stars of mean magnitude 5·2 was $\mu_o = 0''\cdot0566$, and that for five thousand four hundred and thirteen stars of mean magnitude 5·7 was $\mu_o = 0''\cdot0538$, or a change of barely 0″·003 for a variation of half a magnitude. This, like other analyses of considerable numbers of stars, evidences only a slight connection between stellar brightness and proper motion.

One other piece of evidence will complete the sources from which we can draw our conclusion. It is known that the radial motions of the helium stars are exceptionally small. The fact was brought out by Frost and Adams,[4] and by Kapteyn and

[3] *Astronomical Journal*, No. 612, page 99, April 25th, 1910.

[4] "Radial Velocities of Twenty Stars." *Publications of the Yerkes Observatory*, Vol. II, pages 143 to 250.

Frost in the paper "On the Velocity of the Sun's Motion through Space as Derived from the Radial Velocity of Orion Stars."[3] Professor Boss contributed the [illegible] of their proper motions are also [illegible] No. [illegible]. Mr. Benjamin Boss finds that [illegible] Orion stars are moving in directions [illegible] removed from position-angles which [illegible] from the solar apex.[4] The proper [illegible] hundred and sixty-two of these [illegible] cluster around a mean value of 0"·0576. [illegible] solar parallactic motion for the same [illegible] deduced from the entire body of stars included in the research of Professor Lewis Boss is 0"·0549. Hence the motions in question are almost entirely parallactic. Here we have the very thing for which Dr. Crommelin asks, namely, a body of stars of galactic association (the mean galactic latitudes averaging +11° and −12° on either side of the medial galactic circle), and one which reflects the solar motion. Moreover, this is the most convincing testimony that has yet appeared that the apparent solar motion is really solar. If the solar velocity is really as great as four astronomical units per annum, these stars and the associated Milky Way are 5·7 times as far away as the sixty light-years assumed. Further investigations, allowing for independent star-drift, may alter the value ascribed to the solar velocity, but the general order of the distances cannot be greatly changed.

Kapteyn and Frost (*Op. cit.*) find from sixty-one Orion stars having a mean cross-motion of 0"·0123 per annum, a radial velocity, freed from the parallactic velocity, of 6·5 kilometres per second, which corresponds to a parallax of 0"·00924, representing 5·4 times the galactic distance of my preliminary assumption.

There is an indication that the Orion-type stars are moving along two distinct galactic streams which have a trend oblique to the solar motion and away from some common centre, the radial drift for these stars near the solar apex being, in a general way, similar in direction to that of the Sun's motion, though less in amount, while on the opposite side of the heavens the radial drift is opposed to the Sun's motion. The result is that there is a difference of ten kilometres per second in the solar velocity derived from Orion stars near the apex and from Orion stars near the antapex. This conclusion is confirmed both by the measures of Kapteyn and Frost, and by those of Stroobant on Orion stars.

In view of the evidence which is presented here, it appears to me probable that my preliminary value of the galactic dimensions may need to be multiplied by five. The estimates of the nebular distances must also be increased in the same proportion, although it will, of course, be understood that, as this problem lies on the utmost verge of possible solution, any answer to it must be taken with considerable latitude.

Supplementary Note.—Since writing the above, I have seen the article by Dr. Max Wolf in *Astronomische Nachrichten*, No. 4549, in which he also arrives at the conclusion that my earlier estimates of nebular distances and dimensions should be increased about five-fold, but basing his argument on the supposition that the parallax of Nova Persei is 0"·01, instead of 0"·05. This value seems inadmissible for the reasons cited here. The hypothesis that the Galaxy is a spiral with two branches and more than one turn, and that the Nova was on an adjacent branch, will remove this remaining discrepancy.

[3] *Astrophysical Journal*, Vol. XXXII, page 83, July, 1910.

[4] "Systematic Proper-motions of Stars of Type B." *Astronomical Journal*, No. 620, page 163, December 5th, 1910.

EXTENSION LECTURES.

We have pleasure in mentioning the work of the Extension Section of the Manchester Microscopical Society, which each year sends out a list of lectures of a popular character which can be given before societies in and about Manchester, the cost as a rule being limited to the expenses, as the work of lecturing and demonstrating is entirely voluntary and gratuitous on the part of the members. It is obvious, as a rule, that only a few shillings will be asked for from the societies which take advantage of the help which is offered. Occasionally a small fee is demanded, and this is the case where lectures are given before societies which are commercial undertakings, or are subsidised out of Government or public grants. The fifteenth list is before us for the session 1912-1913, and on it are sixty-eight subjects and the names of seventeen lecturers. We quote one or two of the titles: "Some of Life's Simplest Children," "The Natural History of Lizards," "A Study of the Fertilisation of Flowers," "Household Pests," "Prehistoric Man," "The Management of an Aquarium." It will be seen that they are mostly natural history subjects, and secretaries of societies within reach of Manchester, will receive a copy of the list on application to Mr. R. Howarth, the Honorary Secretary and Treasurer, 90, George Street, Cheetham Hill, Manchester.

It would be a very good thing if other Societies were to follow in the footsteps of the Manchester Microscopical Society. The Council of the Selborne Society, we know, has arranged series of local lectures quite apart from its branches, and several of its members have given addresses to some of the local societies which are not able to pay large fees. The South-Eastern Union of Scientific Societies has for many years published lists of their members who are lecturers, with a selection of their subjects. This work, however, might be very well extended and systematised, and we should be glad to hear from any of our readers in any district who are willing to give lectures if their expenses are paid.

THUNDERCLAPS.

By REGINALD RYVES, F.R.Met.Soc.

While the approach of a thunderstorm at night is heralded from a great distance by lightning without thunder, in the day time the growling of the distant thunder is often heard before the lightning is noticed, except by those who are in places where they can see for many miles in the direction of the approaching storm. As the storm comes nearer, the growling develops into a rumbling, but it may still be difficult to distinguish one peal from another, especially if there is a great deal of cloud in the sky. As soon as the peals are distinctly and separately heard we may begin to measure the distances and, if the storm approaches slowly and is well-defined and of small size, it may sometimes be possible to make a fair guess at the size of the storm by noting the distances of the furthest and of the nearest flashes. These distances are measured, roughly, by counting one mile to each four and a half seconds which elapses between the flash and the thunder. The first part of the peal is that due to the nearest part of the flash. When a big and very active storm is approaching the flashes are sometimes so frequent that incessant growling in the far distance is followed by incessant rumbling as the storm comes nearer, and even when the storm is quite near it may be impossible to distinguish one peal from another or even to tell whether the crash which follows several seconds after a flash of lightning is caused by that flash or by some earlier and more distant one. Storms of this character sometimes occur in the British Isles, and they not infrequently accompany severe cyclones in the tropics or mark the advance of the monsoons. These great currents, however, by no means always advance upon the countries which they traverse in the fashion which English writers love to describe; they often begin with ordinary showers or ordinary thunderstorms succeeding one another by longer or shorter intervals, and accompanied by moderate or even scanty rains.

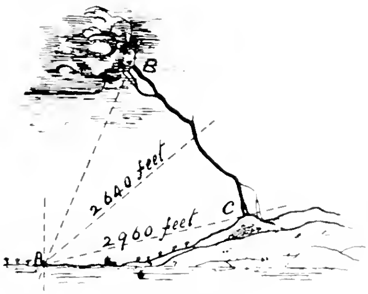


Figure 418.

Any very big circular disturbance, advancing with great masses of cloud and accompanied by smaller and more violent whirls, or areas of cyclonic type, may bring violent lightning and very heavy rain over a fairly broad belt of country; but very often the intensity of the storm depends upon the state of the atmosphere over the country to which it comes. The local condition of the atmosphere, the physical form or topography of the country and the small size of each satellite or subsidiary whirl, carried along with the main "depression" or cyclonic area, are the causes of the great differences in the local intensity of a storm, even when it is a big one. For instance, the great Derby Day storm burst with terrific force over Epsom Downs partly, no doubt, because one of the most intense of the minor whirls passed that way, partly because of the configuration of the country just there, and partly as the result of the electrical strain which already existed over the Downs. This condition of the atmosphere was shown for an hour or two before the storm came, by the occasional falling of very large drops of water, through the dry air, and from a sky only thinly clouded over at a great height. At Dorking there was moderate rain, in the Holmwoods hardly any, a little further south at Ockley the storm was very fierce accompanied by severe hail. Again, the terrific violence of the storm at Westerham on the main ridge of the country, may be compared with the relatively mild experiences in neighbouring places.

Figure 419.

Measuring the Distance.

When a thunderstorm of an ordinary character has approached within a mile or so, or when it is actually passing overhead, it is usually possible to trace each peal of thunder to its flash and, by counting seconds between the flash and the first crack of thunder, to measure, at the rate of four and a half seconds per mile, the distance of the nearest part of the flash. It is a mistake, however, to suppose that by the loudness of the crash, and allowing for its distance, we can judge of the size or force of the flash of lightning. We are usually in error when we turn to one another and say "That was a tremendous flash" or "Something must have been struck." The strength of the flash does, of course, make a difference, but there is something else which will seemingly make the noise of one flash many times louder than that of another which is quite as strong and is no further away. This is the direction taken by the flash relatively to the position of the observer.

WHY THUNDERCLAPS VARY.

Probably a good many of us have noticed that a very brilliant flash, quickly followed by thunder and therefore quite near, often causes only a moderately loud tearing noise, though a long and loud peal follows it. Soon after, perhaps, there comes a less vivid flash followed by an explosive crash or crack of great violence, though the peal which follows it is less loud than that which followed the gentler rending noise of the preceding flash. The explanation is very simple: the length and strength of the peal depend mainly upon the strength and size of the flash and only partly upon its position, while the loudness and sharpness of the crack, which comes before the peal, depends chiefly upon the direction taken by the flash. The crack, or rending noise, comes from the flash itself: the peal consists of echoes of this noise, coming from the clouds.

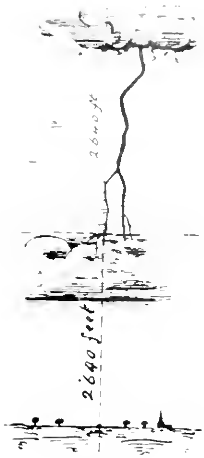


FIGURE 420.

Now, the noise of the actual flash comes to us, not from one spot, but from all along the path of the flash, and it is because of the length of this path that the time taken for the sound to come from the farther end of it is much greater than the time taken for the sound to come from the nearer end. It is only a matter of seconds, but it makes all the difference in the sharpness and loudness of the crack or rending noise. If the whole of this noise, from all along the path of the flash, reaches us in a quarter of a second, say, it sounds like a terrific thump or sudden crash; but if it takes two or three seconds for all of it to reach us, we hear it as a long rending noise. By noting with accuracy the duration of the rending noise of a big flash which could be identified by the exact time at which it occurred, three or four pairs of observers could measure the length of a flash of lightning and fix its position in the sky. The observers should be in pairs, and one of each pair would note the interval between the flash and the beginning of the crash, so as to get the distance, while the other, with a stop-watch, noted the duration of the crash. The possibility of doing this depends upon the two facts, that the time taken by the flash to traverse its path is immeasurably short, and that the time taken for the light of it to travel to the observer may also be counted as nothing.

SOME TYPICAL EXAMPLES.

The differences in the positions of flashes relative to the observer, and the effects on the duration of the crash or rending noise as distinct from the pealing echoes, are illustrated by the accompanying diagrams. If, for instance, the observer is at the point A in Figure 418, and a flash of lightning half a mile long and half a mile away from him passes from B in the cloud to C in another cloud or on the hill, the sound from the two ends of the flash will reach him in twenty-nine hundredths—less than one-third—of a second after that from the middle of the flash, since it only has to travel three hundred and twenty feet further. Sound travels through air at a speed of one thousand one hundred and forty-two feet per second. Suppose, now, that a flash half a mile long occurs as in Figure 419, passing from D to E, then the difference in distance between the longest path and the shortest path traversed by the sound is, in round figures, one thousand and ninety feet, and the noise from E will reach the observer nearly a second later than that from D. He will hear the noise of the crash spread out as a rending sound over the space of one second, and the noise will only be about a third as sharp as that of the former flash of the same strength.

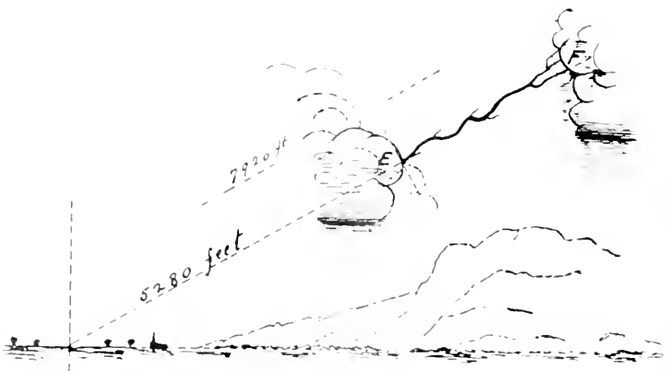


FIGURE 419.

Let us now look at Figure 420, which represents a flash half a mile long, passing between a cloud which is half a mile above the observer and another cloud half a mile further overhead. In this case the sound of the flash will be spread over rather more than two and a quarter seconds. If both clouds were higher up, but the same distance apart, the "period of total arrival," as we may call it, would be the same, all the sound taking longer to travel the increased distances, all arriving later by the same interval of time. The flash would make a crash equally sharp but less loud because further away.

Turning now to Figures 421 and 422, if a flash starting from a point E, a mile away from the observer, strikes from cloud to cloud as in Figure 421, the noise from the far end reaches the observer about two and a quarter seconds after the noise from the nearer end. If, however, a flash which is a mile away at its nearest point strikes the cliff as in Figure 422, the whole sound of the crack reaches us in about one-seventh part of a second. We should, therefore, hear a crack about sixteen times as sharp as in the former case. Being also nearer it would for that reason be somewhat louder, but the effect of the new direction is, clearly, far more important. Apart from such differences as are produced by the positions of the clouds which are between us and parts of some of the flashes, we now see how it is that a very brilliant flash such as that in Figure 421 might be, may produce a noise much less sharp than that of a less vivid flash taking such a path as that in Figure 422.

It must not be supposed that the noise will be greater because the flash strikes the ground. When electricity passes along, or is distributed in solids or liquids, nothing happens at all corresponding to what produces the crack or clap in the air: the expansion due to the heat of the flash and the sudden contraction following it. When lightning strikes into or near water the sound may reach the observer by way of the water more quickly than through the air, for sound travels more than four times as fast through water as it does through air; but on land the difference is not so great. Through solid granite sound travels half as fast again as through air: but since its speed through granite as it usually occurs in the hills is not much greater than the speed through air; and since, too, the rate at which it travels through wet sand is a good deal less than its speed through air, it is clear that as a rule the sound coming through the ground will lag behind that which comes to us directly from the flash.

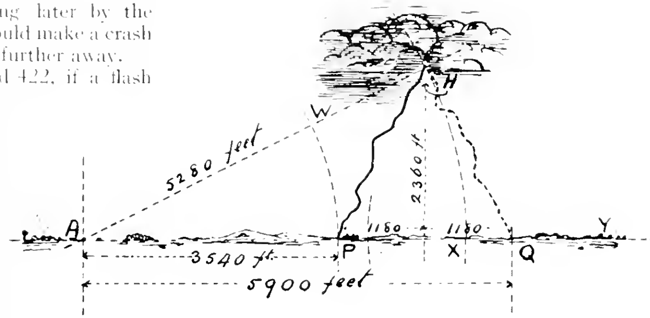


FIGURE 423.

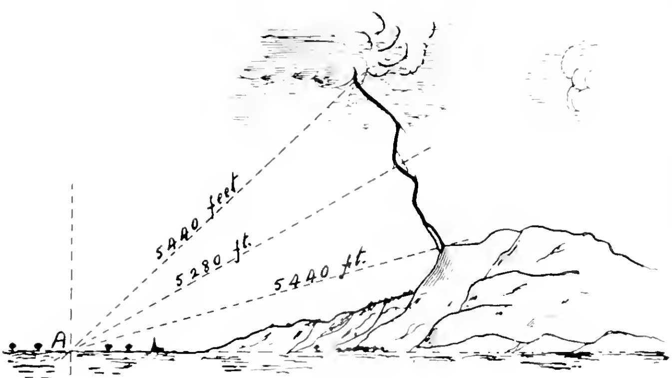


FIGURE 422.

A FLASH STRIKING THE GROUND.

When a flash strikes the ground the sharpness of the crash may depend upon where it strikes, and the nearer stroke is not necessarily the louder—strength and length being equal. Suppose that a flash starting from H in Figure 423, strikes the ground at Q, the difference between the nearest distance and the furthest distance is six hundred and twenty feet giving a "period of total arrival" of rather more than half a second. If a similar flash strikes at P, the nearest point is three thousand five hundred and forty feet away, the furthest five thousand two hundred and eighty feet, and the difference one thousand seven hundred and forty feet, giving a period of total arrival of more than one and a half seconds. In the former case the handicap is from Q to X, in the latter, from H to W. This figure, in which an arc of a circle with centre at A is drawn through H and X, suggests that some of the loudest crashes and those that are very loud considering their distance from the observer, are due to the lightning following a path which approximates to the circumference of the arc, such as H X, so that all the noise reaches the observer in a small fraction of a second, a shorter period, even, than in such a case as that of Figure 418. Loudness is, of course, due in some cases to the flash being very near, say within a few hundred feet, when the nearness of the nearest part of it makes up for a necessarily fairly long "period of total arrival."

THE GOLD AND SILVER SHIELD.

In comparing accounts which different persons give of the same occurrence, the very diversity which is sometimes so informing to the expert merely serves to mystify those who have not studied the principles which dominate such occurrences. This is especially true of natural phenomena, with respect to which differences of position and of distance are not always accorded the consideration which they demand. Two witnesses may differ, and both be right. A very striking example of this is furnished by Figure 423. Leaving out of consideration the dotted flash from H to O, let us fix our attention on the flash from H to P. Suppose that this flash struck a factory and did much damage, at exactly eight o'clock in the evening. At a quarter to eight, near the place marked Y, a man was, let us suppose, found murdered, just dying from a recent wound inflicted by a knife belonging to Tom Cornseed, a man employed on the farm at A. This man usually leaves the farm at about seven o'clock to walk to his home near Y. Some other circumstances point to his guilt, but two reliable witnesses swear that he was at the farm, A, *till the big flash of lightning that struck the factory*. These witnesses had no watches, and the usual work of the farm had been disturbed by the storm, which had also made the evening unusually dark. Their only knowledge of the time, with any accuracy, is that afforded by the great flash. This they describe as very bright, and followed by a loud peal, but not followed by a very sharp crack. A witness at Y, having an accurate watch, describes the stroke at eight o'clock as being followed by one of the sharpest and loudest cracks he ever heard. The two farm witnesses, re-examined, waver in their evidence, but under cross-examination go back to their first statement and hold to it doggedly. Is the man Tom Cornseed to be hanged? It depends upon whether anyone concerned is alive to the fact that the evidence is not conflicting, and is able to convince the judge and jury of this fact. What would a capable assessor do? He would first point out that the observer at Y, though the same distance from P as those at the farm A, might be, as in Figure 423, some one thousand feet or so nearer to the flash, on the average. He would then show, from Figure 423, how the point P might be only some four hundred and twenty feet further from Y than the point H, while the difference between the distance of P and H from A is one thousand seven hundred and forty feet. The "period of total arrival" at A is, therefore, more than four times that at the point Y, which accounts for the noise being less loud. So far the evidence is shown to be not necessarily in conflict with that by the witness at Y. If, now, the assessor can find witnesses from a mile or so away, to either side, or both sides, whose evidence shows that the flash did start as in Figure 423, then the evidence of the farm people is shown to be in accordance with probability and is all the more likely to be reliable.

THE POSER AND THE INTERPRETER.

It is a remarkable fact—probably due to the arrogance of a certain type of person who calls himself a "scientist"—that a very large number of persons set their faces resolutely against the acceptance of explanations of natural occurrences. The same persons will accept without question the statement that Mr. Edison has invented an electrical storage battery which will revolutionize all applications of power; or that one Tesla, has found out how to communicate, electrically of course, with the planets. They cannot believe, however, that an ordinary person who neither wears spectacles nor smokes strong cigars can possibly be able to explain how the tides occur, or why the lightning speaks sometimes with an explosive crack, sometimes with a rending crash, and sometimes with a loud peal which, repeated from many clouds, reaches when the distance is too great for us to hear the noise of the flash itself. Yet we make many mistakes because, in probing into the future, we fail correctly to interpret the present.

NOTICES.

EARLY MICROSCOPES.—In Hull Museum a serious attempt is being made to illustrate the growth and evolution of various exhibits, whether they be spinning wheels, bicycles, lighting appliances, or corsets, and an opportunity having recently occurred of showing a series of instruments bearing on the development of the microscope, Mr. T. Sheppard, the Curator, describes them in the August number of *The Naturalist*. The paper is illustrated, and the figures show specimens ranging from the "screw barrel" microscope held in the hand and used about the year 1725 to a more imposing one dated 1780. The latter is of interest because it belonged to Charles Sherborn, who lived from 1796 to 1858, to the late Charles William Sherborn, who died in 1912, and was presented to the Museum by Mr. Charles Davies Sherborn and his brother, Sidney Newton Sherborn.

WASPS REMOVING FROM THEIR NEST.—Mr. J. Edmund Clark, of Purley, sends the following interesting note to *The Gardeners' Chronicle* for August 31st. A powerful nest of wasps established itself among the Alpines last July in the garden of Mr. H. F. Mennell, Park Hill Rise, Croydon. One afternoon, as hundreds of the insects were flying in and out, Mr. Mennell and his daughter stood within two yards for some while, unmolested and unmolesting. They decided to treat the nest that night with boiling water and paraffin oil, for it was in level ground. Coming back a quarter of an hour later, they were astonished to find the wasps busier than ever, but all flying off in one direction over a fence, laden with eggs, grubs and pieces of the nest. In about an hour the place was practically deserted, as it has remained to date (August 22nd), though the hole has not been touched.

ON COOKED FOODS.

By KATHARINE I. WILLIAMS, B.Sc.

The University, Bristol.

In this article the question of foods, especially cooked fish, vegetables and cereals is dealt with from the chemical point of view.

For many years the author has been engaged upon the investigation of the chemical composition of such food materials, and the suggestion has been made that the general public, and not only the chemical world, might be interested in this important subject. In America the question is brought before the public to a much greater extent than it is in England: a great deal of valuable information has been published there. Congress has granted money to the Department of Agriculture, bulletins on the subject are distributed freely, and several of the so-called Farmers' Bulletins deal with the uses of milk, fish, eggs and other ordinary kinds of nourishment.

It is hardly necessary to state that to be of real value all such investigations must be quantitative: that is, must show in percentages the amounts of the various constituents present. The first recorded quantitative analysis of any food was made in this country by George Pearson in 1795, who determined the proportion of water, starch, ash, fibre and extractive matter in kidney potatoes. For about eighty-five years similar work was carried on in Europe, chiefly in Germany. Since then many American chemists have devoted themselves to this subject. *Bulletin No. 28* (Office of Experiment Stations, Department of Agriculture), prepared by Professor Atwater and A. P. Bryant, entitled "The Chemical Composition of American Food Materials," contains details of the analyses of four thousand and sixty American articles and commodities used for human food in that country, but in most cases the food is uncooked.

During the last few years Professor Grindley, in the University of Illinois, and others have devoted themselves to the study of the effect of various methods of cooking meats.

It is well to understand what is meant by food, and the definition given by Dr. R. Hutchinson in "Food and the Principles of Dietetics" is perhaps the simplest that can be given—"anything which, when taken into the body, is capable of either repairing its waste or of furnishing it with material from which to produce heat or nervous and muscular work." Other substances may have a useful place in our dietary, though not falling into the category of food-stuffs. Later on it will be seen how various commodities answer to this description. The ordinary articles of diet are mixtures of various chemical substances, some of which are of value as nutrients, others are not. Of the former the most important are the nitrogenous; as the name implies they all contain nitrogen. They are known under various names: gluten in bread, legumin in the pulses, but are commonly spoken of as the proteins.

Non-nitrogenous is a general name for the carbohydrates, starch, sugar, and so on, also the fats, such as butter. Table salt and other mineral matters, and water, are also of importance; the latter is not only contained in the liquids we drink, but also forms part of the solids we eat.

The main object of the investigations now to be considered was to arrive at a clear idea of the value of foods as served at table, and the results show that many wrong impressions exist as to the proportion of nutrients they contain.

In commencing the study of a food, the first stage is to weigh the sample; then, if it is fish, it must be cleaned, the scales scraped off, the refuse weighed; with such vegetables as cabbage and broccoli the outer leaves must be removed; the pods of peas and beans all come under the head of refuse; the pods, however, have a value for soup. With potatoes the skins should not be removed before boiling, as valuable salts are mainly found in the layer just under the peel.

WASTE BEFORE COOKING.

In 100 parts.

Food	Refuse.	Food.	Refuse.
John Dory ...	$21\frac{1}{3}$	Spinach	25
Gurnet	9	Green Artichokes	$72\frac{1}{3}$
Broccoli	68	Green Peas ...	45

The sample is again weighed, and cooked, and is then in the condition in which it would be served at table. It is then re-weighed to ascertain the increase or decrease in the amount of water gained or lost.

All waste is removed, such, for instance, as the bones and head of fish, the hard part of asparagus. With cereal foods, on the other hand, there is no refuse.

REFUSE AS SERVED AT TABLE.

Name.	Refuse.	Name.	Refuse.
John Dory ...	21	Haddock... ...	35
Salmon (section)	6	Asparagus ...	34
Herrings... ...	12	Green Artichokes	69

We now pass to the main question, what is the value of the edible portion of the various cooked foods? And the first point to consider is the amount of water, which is most important, as we could not live on dry foods; but, on the other hand, it is clear that a high percentage of water will result in a bulky food. During the process of cooking, meat and fish decrease in weight; in almost every case vegetables increase, and cereals always do so.

Unfortunately, details were not kept as to the weight of the fish before cooking, but as will be shown, the percentage amount of water is lower in the cooked than in the uncooked samples.

With regard to meat it is stated that however cooked it loses from one-fifth to one-third of its weight.

Johnston found:

	In Boiling.	In Baking.	In Roasting.
4 lbs. of Beef lose in weight ...	1 lb.	1-lb. 3-ozs.	1 lb. 5-ozs.
4 lbs. of Mutton lose in weight ...	14 ozs.	1-lb. 4-ozs.	1 lb. 6 ozs.

Professor Grindley observed that on boiling lean beef it lost forty-four and two-thirds per cent. of its original weight; at a temperature of 85° C., a similar sample boiled in boiling water lost forty-five per cent. He found, further, that beside losing water, some of the fat, mineral matters and protein are dissolved out at the same time, and on examining the extracts he found as the average of ninety-one samples that the loss of mineral matter was forty-four and a half per cent. of the total amount present in the meat, of fat twelve per cent., and of protein seven and a quarter per cent. In the process of stewing, highly flavoured soluble matters are removed from the meat and transferred to the bouillon.

At the same time comparing the nutrients in cooked and uncooked meats, we find a higher percentage of nutrients in the cooked condition and a lower percentage of water.

One great difficulty that confronts the food chemist is the material he works with: individually one sheep is not exactly like another, one may be fatter, another leaner; so with fish, vegetables and cereals. It is stated by Professor Snyder that in the case of flour containing twelve per cent. of moisture, if one hundred pounds be kept in a dry place a reduction of three pounds in weight may be observed, whereas in a damp place a corresponding increase may take place. Therefore, in this class of analysis only approximations can be made, and it is important to obtain as much information as possible, repeating the examination of articles of food, and taking the mean of a large number of analyses.

Thus, with three samples of uncooked American halibut it was found:

Edible Portion.	Water	Protein	Fat	Ash
Minimum	70	17½	2·0	1·0
Maximum	79	20	11·0	1·1
Average	75	19	5·0	1·0

Six samples of mackerel were also analysed:

[illegible]	Water	Protein	Fat	Ash
Minimum ...	64	17½	2	1
Maximum ...	79	19½	16	1½
Average ...	73	19	7	1

When first the work with vegetables was started it was impossible to judge how much vegetable was required: in three cases the supply fell short, and fresh samples had to be prepared the following year, giving very different results on the dry basis for protein.

	Sea Kale	Parsnips	Potatoes
I.	41	12	13
II.	27	15	11

These data confirm the fact long known, that the nitrogenous compounds vary (*a*) with the maturity of the plant (*b*) variety of the plant (*c*) soil and cultivation (*d*) the season. In our present state of knowledge we assume all the nitrogen of our foods exists in the form of protein, but research is showing that some is present as non-proteid; further, that proteids differ considerably from each other; one form is found chiefly in nuts, another in meat. Often a mixture of various kinds is present, and the important question of the replacement of one form by another is being investigated by Dr. E. F. Armstrong and others. One important point requiring investigation is the question of loss in the cooking of vegetables. Whenever possible they should not be cooked in an excess of water, which it is necessary to drain off afterwards. Professor Snyder, at the University of Minnesota, made a study of the loss of nutrients in potatoes, cabbages and carrots; he states that one hundred pounds of uncooked cabbage only contain seven and a half pounds of solid matter, and of this two and a half to three pounds are lost in cooking, the loss consisting of protein, mineral matter, and carbohydrates. With carrots cooked in small pieces twenty per cent. to thirty per cent. of the total food material is extracted; the average of seventeen American analyses shows only 11·¾ of solid matter, while the average of thirty-five European analyses shows 13·2, and of this from two and a half to four pounds (mainly consisting of sugar, mineral matter and protein) is lost.

With potatoes it was found that the loss suffered on boiling was inconsiderable, provided they were unpeeled. With spinach we have only ten pounds of solid matter in one hundred pounds; when drained after cooking the loss is two and a quarter pounds. Celeriac nine and a-half pounds solid in one hundred pounds, and the average of three samples shows that four and a half pounds are lost. Borecole, or curly greens, one hundred pounds contain ten and one-third solid, and of this five and a quarter pounds are lost. Turning to a still more common article of food, rice, it is frequently boiled in an excess of water, which is then drained off. In this process protein, fat and mineral matters are lost. Now rice contains but very little of these nutrients to start with, and in the East the native soldiers prefer to have the liquid which has been drained off, and leave the residue for the English soldiers. All this loss can be avoided by boiling the rice (according to the American receipt) in two and a half times its bulk of water for twenty minutes, then placing the saucepan on a tripod, covering it with a piece of cheese cloth, and allowing it to remain covered for an hour; at the end the rice will be tender and sweet. As a rule all vegetables, except in a very few cases, weigh more after cooking; all show a high percentage of water; so, in the case of loss of weight it must be due to the loss of nutrients. This increase of weight tends to make all vegetable and cereal foods bulky. One hundred ounces of green artichokes after cooking weigh three hundred and thirty-six ounces; one hundred ounces, brussels sprouts, one hundred and twenty-one ounces; leeks, one hundred ounces become two hundred and fifty-two ounces; one hundred ounces lentils, two hundred and thirty-eight ounces; one hundred ounces arrowroot, one thousand one hundred and fifteen ounces; one hundred ounces quaker oats, one thousand one hundred and ten ounces; one hundred ounces mother's oats, nine hundred and twenty-five ounces; one hundred ounces rice, four hundred and eighteen ounces.

The percentage of water is one of the most important points in food analysis; we want to know how much solid food we really consume. Considering meat and fish there is a higher percentage of solid matter, and the whole of the flesh consists of nutrients, fat, protein, and mineral matter. But in vegetable and cereal foods, on the other hand, besides these nutrients there is a framework of cellulose or woody fibre; according to some authorities this has a value from the food point of view, but it is doubtful. In the process of cooking the framework is ruptured, and the starch inside is gelatinised; the change may be observed in well-cooked potatoes.

TABLE SHOWING PERCENTAGE OF WATER AND SOLIDS IN VARIOUS ARTICLES OF FOOD BEFORE AND AFTER COOKING.

Name	Cooked		Uncooked	
	Water.	Solids	Water	Solids
Beef	57	43	71	29
Mutton (leg)	51	49	63	37
Lamb	67	33	72	28
Veal (cutlets) ...	58	42	72	28
Cod	76	24	82	18
Haddock	68	32	78	22
Lentils	66	34	12	88
Green Peas	87	13	75	25
Dried Peas	62	38	14	86
Onions	99	1	82	18
Carrots	93	7	86	14
Cabbage	97	3	89	11
Vegetable Marrow ...	99	1	95	5
Rice	81	19	13	87
Quaker Oats ...	92	8	13	87
Arrowroot	93	7	16	84

The table shows the effect of cooking as regards the percentage of solid matter in the cooked and uncooked articles; increase in nutrients in the case of fish and meat, decrease in solids with vegetables and cereals following the cooking process. Only edible matter is considered; that is, the flesh of the meat and fish, and the portion of vegetables that can be eaten as food.

At this stage it is possible to judge which foods, bulk for bulk, contain most nutrients, but this does not conclude the matter; for it is further necessary to know the nature and the percentage of each nutrient. The human body requires certain amounts of fat, carbohydrates (that is, starch and sugar), mineral matter and protein daily. Protein can fulfil the functions of food in all respects as a tissue former, and also yields heat and energy, with the help of water and mineral matters; that is, salts such as sodium chloride or table salt; but under ordinary conditions fats and carbohydrates are necessary as energy-producers. Studies as to dietaries have been made in England, America, Germany, Sweden, Russia, and Japan among various classes of people, those doing hard and moderate work, factory operatives, tailors, college football teams, those employed in intellectual work, soldiers in time of peace and war. Taking the average, they conform fairly well to the standard drawn up by Professor Atwater; four and a half ounces protein, sixteen ounces carbohydrates, and four and a-half ounces fat for a man doing moderate work. To a certain extent fat and carbohydrates can replace each other, and it is estimated that for every part of protein four and three-quarters of carbohydrates and fat are required. It is understood that this standard is for the average man; in the case of women, ·8 of the above amounts is sufficient, and children require less in proportion to their age.

At the present time there is a good deal of discussion on the question of proteid, and experiments have been made by Professor Chittenden, of Yale, and others, who state that the human body only needs about half of the amount mentioned above, even two ounces are stated to be sufficient; but until more is known, Professor Atwater's or similar standards will hold their own.

Now the results of analysis can be stated in two ways, and one of these has led to the many false ideas which at present are in circulation among the general public. The dry powdered sample must be used for the estimation of fat, and so on, and in many books results are stated on this basis, and the important factor *viz.*: the percentage of water present is left out of the question. The other and correct method is to give tables including the water and calculating the fat, and so on, in the natural moist condition of the food as actually eaten. The two following tables will illustrate the false and correct method of describing the results of analysis.

Dry Powder.

(Analysis from which false deductions can be drawn.)

Names.		Mineral Matters.	Protein.	Fat.	Carbo-hydrate.	Fibre.
Oswego ...	...	1	23		76	—
Quaker Oats ...	...	3	22	4	81	1
Mother's Oats	...	2	12	1	85	1
Lentil ...	...	2	26	1	68	2
Peas	...	2	25	2	61	6
Brill	...	4	94	2		
Halibut ...	...	4	80	16		
Herrings ...	...	6	67	25		
Beef (Boiled)	...	3	80	17		
Veal (Roasted)	...	3	68	27	—	—
Mutton ..	...	2	51	46		

Natural Moist Condition—as Served at Table.

(Correct Method of Analysis.)

Names.	Water.	Mineral Matters.	Protein.	Fat.	Carbo-hydrates.	Fibre.
Oswego ...	87	-	3		9	—
Quaker Oats...	92	¼	2	⅓	6	
Mother's Oats	90	—	2	½	9	—
Lentils ...	66	¾	9		23	¾
Peas	62	¾	9	⅓	23	2½
Brill	63	2	35	½	—	—
Halibut ...	74	1	20	4	—	—
Herrings ...	60	2	26	10	—	—
Beef (Boiled)	57	1	34	7	—	—
Veal (Roasted)	58	1	29	12	—	—
Mutton	51	1	25	23	—	—

One of the most important factors to consider is the amount of protein present in the food. In books treating of the subject the statement is often found that the pulses are rich in this nutrient, and for this reason are called "poor man's beef." Analysis clearly shows that such statements are entirely incorrect. But to understand why this view has been put forward it is only necessary to study the following table, which shows the composition of some of these foods in the uncooked condition, *i.e.*, not in the conditions in which they are eaten.

Approximate Composition of Uncooked Foods in the Natural Moist Condition.

Names.		Water.	Mineral Matters.	Protein.	Fat.	Carbohy-drates.	Fibre.
Beef ...	...	71	1	22	4		
Veal ...	...	71½	1	20	6		
Mutton	...	67	1	20	12		
Lentils ...	...	12	3	22	1	2	59
Peas (dried)	...	14	2	21	2	6	55

The samples used are the same as those analysed in the cooked condition, with the single exception of mutton. When these tables are compared it is seen that in the uncooked condition the protein of the sample analysed is nearly the same, but when served at table there is an enormous difference: the lentils and peas which before cooking contain twenty-two per cent. and twenty-one per cent. contain after cooking only nine per cent., and while beef containing twenty-two per cent. rises on cooking to thirty-four per cent., veal from twenty per cent., to twenty-nine per cent.; even on the basis of the cooked dry powder the amounts of protein present show that pulses cannot yield the same amount of protein as meat. The reason of this great difference is, of course, the change in the amount of water after cooking, a loss in the case of meat, and a large gain in the case of vegetable foods.

A new campaign has arisen lately whose watchword is "Fish as Food." From what has been stated the amount of protein is satisfactory; but the difficulty is to get a really fresh supply, as when not fresh it is hardly a wholesome form of food, and to be avoided when served with various sauces to conceal the unsavoury smell in a stale condition. Many base their praise of fish on the idea that fish is an excellent brain food because it contains phosphorous, but Dr. Hutchinson, in "Food and the Principles of Dietetics," says: "It has never been shown that an increased supply of phosphorous in the food is specially favourable to mental effort, nor, indeed, has it been proved for any other food." But even if it were true that phosphorous is such an important point, a fish diet could be of no value; for the amount of that substance present is so extremely small.

As served at table the edible portion of herring only yields one-fiftieth per cent., sprats one-sixth per cent., trout one-seventh per cent., and turbot one-tenth per cent. in each case. Atwater made investigations on the same point on raw fish with a similar result.

The work of the food chemist is to analyse food materials, so that those more competent can draw up suitable dietaries; but even this is not an easy matter; to get a proper supply of the various nutrients needed, mixed rations are necessary. Lentils are excellent; but if we wish to obtain the full supply of protein from this source, it is necessary to consume one pound one and a half ounces per day (allowing ten per cent. for waste of protein in the process of absorption) and this when cooked would amount to four pounds six and a half ounces; one pound five ounces of cooked beef would serve the same purpose, and would be less bulky. The proteid from animal sources is said by most medical authorities to serve the body better as food than that from the vegetable kingdom; the fibre in the latter is also a disadvantage. Some of the everyday mixtures of food have a scientific value: bread and cheese, the former a source of carbohydrates, the latter for protein, bacon and beans, fat and protein, bacon with fowl to supply the required fat. No one food can supply all our requirements, except milk in the case of infants. We can obtain our supply of carbohydrates from two pounds thirteen ounces of bread, but to secure enough protein we should require three pounds fourteen ounces, giving a large excess of starch. With potatoes, eight pounds seven ounces would supply the starch, but twenty-two pounds eight ounces would be needed for the protein, and this would be a very badly-balanced ration.

The money value of a food does not always agree with its true value in the ration: herrings are cheap and contain a high percentage of protein; properly cooked the cheaper joints of meat are as useful as the more expensive. The cheaper forms of arrowroot serve the same purpose as the most expensive. The body gets accustomed to certain foods. In America, for instance, it is said that immigrants from Southern Europe find it difficult to give up their maccaroni, olive oil, and their native kind of cheese, and take to the foods of their new home. Travellers in Switzerland will buy Brand and Bovril and complain of the price, while the Swiss-made Maggi answers the same purpose.

Professor Snyder, in "Human Foods and their Nutritive Value," calls attention to what he calls food notions—the false ideas that arise. Mushrooms are regarded as equal in value to beef, which chemical analysis entirely fails to confirm. Many valuable and wholesome foods are banished from the table, and incorrect views spread abroad. The value of a food must in the first instance be based on its chemical composition; after this the question passes into the hands of physicians and physiologists, and they alone can give the final verdict.

CORRESPONDENCE.

OBSERVATIONS OF SOME RECENT METEORS.

To the Editors of "Knowledge."

Sirs,—The following notes which I have made from observations of recent bright or otherwise unusual meteors may be of interest to some of your readers.

1912, May 5th.—At about $9^h\ 22^m$ C. S. T., a very brilliant and fine meteor was observed to pass just a small distance *s.* of δ Leonis, remaining visible for about two or three seconds, and moving in an E. to W. direction over about 8° of arc. During its flight it seemed to throw off matter from its head, thus leaving a train that was particularly bright immediately back of the head but that went out soon after the meteor was extinguished. The meteor was rich yellow in colour. Directly following this, a faint and rapid meteor was seen in practically the same part of the sky, while earlier in the evening one or two similar ones had been witnessed in the northern heavens.

1912, May 8th.—About $8^h\ 57^m$ a fairly bright, rapidly moving meteor was observed to pass from a point in the *s.* part of Ursa Major to a point approximately 7° *f.* α Leonis, or over a distance of roughly 35°. This object lasted during the time of about three seconds, and left no perceptible trail to speak of, but "went out" practically all at once, breaking very little in the action; just before its extinction the meteor apparently seemed to very slightly "swivel" in its course a bit toward the E., but whether this effect was merely an illusion, I do not know.

1912, May 17th.—At about $8^h\ 29^m$, approximately 10° *s.* β Herculis, I saw what was obviously a bright spark of light flash into view and instantaneously become extinguished, travelling, to my certain knowledge, an absolutely imperceptible distance, and leaving no visible train. The phenomenon could not have lasted more than $0\cdot5^s$. This was one of the most peculiar meteors it has ever been my fortune to observe.

1912, May 22nd.—About $8^h\ 30^m$ I observed an apparently faint, slowly moving meteor which became visible near Capella and travelled over about 5° of the sky *s.* of that star, before going out. It was partly obscured by deep haze or clouds, did not leave much train, if any, and, probably on account of the clouds, appeared to have a kind of bounding movement in the course of its flight, which caused it to be very noticeable.

1912, June 19th.—At approximately $13^h\ 45^m$ (C.S.T. astro.), I incidentally caught a fine meteor that moved from a point somewhere *p.* α Aquilae to a point possibly *f.* α Ophiuchi, (these uncertainties arise from that fact that I was unable to note accurately the positions of its start and finish), parallel to the plane of the horizon, and remaining visible probably as long as two seconds. It left no noticeable trail, was comparatively bright, and white in colour. After it disappeared, however, it left a beautiful and evident streak which remained apparent for some three seconds or more.

1912, July 23rd. While observing with my three-inch equatorial, at about $8^h\ 44^m$, I happened to glance up at the sky and saw a fine meteor move *n.* a few degrees, and, at its very best, become suddenly extinguished at a place approximately 1½° or 2° *s.* and slightly *p.* δ Aquilae. Just before the meteor went out it displayed in rapid succession several hues, but especially a light or pale blue. As it went out, it reminded me more of a great diamond sunburst in shape than any other thing I could think of, the rays of light from its nucleus apparently diverging shortly in all directions from the centre. This meteor was of comparatively small duration (being visible about $2\cdot5^s$ or 3^s), and was another one of the most peculiar examples of its class that I have ever witnessed, it seeming to suddenly go out while at its very brightest. Its colour changes were also interesting; but not as much so as its behaviour.

FREDERICK C. LEONARD,
President S.P.A., M.B.A.A.

Illinois, U.S.A.

THUNDERSTORMS.

To the Editors of "Knowledge."

Sirs,—With reference to the statement of your correspondent, Mr. Tankerville Chamberlayne, that in reports of thunderstorms they are always described as coming up from a distance, and never as starting immediately overhead, it might interest him to know that out of the numerous thunderstorms we have had this year at Stafford, in two cases at least the first flash was overhead (provided a radius of one mile is reckoned as overhead).

In the first case, it was the bright afternoon of a showery day, when, without any warning (the sun was actually shining, or had been shortly before), there was a vivid flash of lightning, immediately followed by a loud peal of thunder; afterwards there was rain and some more thunder, but at a greater distance. This flash killed a boy, who was playing in a field with two other boys, about half a mile from where I was.

In the second case it was about 1.20 p.m., the sky was very overcast and there was heavy rain. I had just gone out of doors and had not taken many steps before there was a particularly vivid flash of lightning, followed by one of the most startling cracking peals of thunder I think I have ever heard. Afterwards there was more thunder and lightning, but at a much greater distance. This flash killed a cow in a shed situated about three-quarters of a mile from where I was walking.

In both these cases the first observed flash was practically overhead, and of course in the first case it was, as far as the boy that was killed was concerned, overhead in the strictest sense of the word.

In two other storms here this year two houses were struck within less than a mile from where I was, but in neither of these two cases have I any record as to whether they were struck by the first flash or not.

H. AUBREY P. HOWARD.

Stafford.

THE FACE OF THE SKY FOR NOVEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

[illegible]

TABLE 41.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Saturn. P	Saturn. B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 42.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T_1 T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN moves South at a slackening rate. Sunrise during November changes from 6 53 to 7 41; sunset from 4-35 to 3 53. Its semi-diameter increases from 16′ 9″ to 16′ 15″.

MERCURY is well placed as an evening star, especially for Southern observers. On November 23rd the disc is half illuminated, semi-diameter $3\frac{1}{2}$″.

VENUS is an evening Star, drawing away from the Sun. Illumination five-sixths, semi-diameter $6\frac{1}{2}$″.

THE MOON. Last Quarter $2^d\ 3^h\ 38^m m$; New $9^d\ 2^h\ 5^m m$; First Quarter $16^d\ 10^h\ 43^m e$; Full $24^d\ 4^h\ 12^m e$. Perigee $3^d\ 11^h m$, semi-diameter 16′ 11″; Apogee $16^d\ 10^h m$, semi-diameter 14′ 48″; Perigee $28^d\ 11^h m$, semi-diameter 16′ 16″. Maximum Librations, November 1^d 7 S., 10^d 5 W., 13^d 7 N., 22^d 5 E. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is an evening Star till 5th, but practically invisible.

JUPITER is an evening Star, increasing its distance from us, so that the equatorial semi-diameter diminishes from 16″ to $15\frac{1}{4}$″. The Polar is smaller by 1″. The configurations of the satellites at $5^h e$ are for an inverting telescope. (See Table 44.)

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h. m.		h. m.	
Nov. 1	ω^1 Cancri	6·1	3 56 *m*	62	5 0 *m*	300
,, 1	ω^2 Cancri	6·2	4 40 *m*	140	5 37 *m*	248
,, 16	κ Capricorni	4·8	2 7 *e*	47	3 10 *e*	207
,, 18	χ Aquarii	5·3	6 17 *e*	18	7 22 *e*	207
,, 21	B.A.C. 1055 ...	6·0	1 25 *m*	4		
,, 24	36 Tauri	5·6	4 7 *e*	32	4 40 *e*	200
,, 25	χ Tauri ...	5·3	0 32 *m*	31	1 25 *m*	301
,, 26	B.A.C. 1746	6·5	5 7 *m*	65	6 7 *m*	271
,, 27	49 Aurigae	5·1	2 10 *m*	67	3 14 *m*	305
,, 28	ε Geminorum ...	3·5	4 14 *m*	127	5 20 *m*	269

TABLE 43. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Day	West	East		Day	West	East	
Nov. 1	421	3		Nov. 11	2	134	
.. 2	4	13	2●	.. 12	2314		
.. 3	14	23		.. 13	34	12	
.. 4	2	13		.. 14	43	2	1●
.. 5	1	4		.. 15	42		
.. 6	3 ☉	24		.. 16	42	13	
.. 7	3	124		.. 17	41	23	
.. 8	21	4	3●	.. 18	32	13	
.. 9	2	134		.. 19	4213		
.. 10	1	234		.. 20	34	1	

After November 20th, Jupiter is too near the Sun for convenient observation of satellite phenomena.

TABLE 44.

Satellite phenomena visible at Greenwich. $1^{d}\ 4^{h}\ 46^{m}\ 42^{s}$ III. Ec. R.; $6^{d}\ 4^{h}\ 35^{m}$ I. Tr. I.; $5^{h}\ 17^{m}$ I. Sh. I.; $7^{d}\ 4^{h}\ 37^{m}\ 35^{s}$ I. Ec. R.; $9^{d}\ 5^{h}\ 3^{m}$ II. Oc. D.; $18^{d}\ 4^{h}\ 48^{m}$ II. Tr. E.

All the above are in the evening hours.

The eclipse reappearances of I. II. and both phases of those of III. occur high right of the inverted image, taking the direction of the belts as horizontal.

SATURN is in opposition on 23rd. Polar semi-diameter $9\frac{1}{2}''$. The major axis of the ring is $47\frac{1}{2}''$, the minor axis $19\frac{1}{4}''$. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). November $1^{d}\ 6^{h}\cdot9$ *e*, $9^{d}\ 8^{h}\cdot0$ *m*, $16^{d}\ 9^{h}\cdot2$ *e*, $24^{d}\ 10^{h}\cdot3$ *m*. Dione (every third given). November $1^{d}\ 1^{h}\cdot5$ *e*, $9^{d}\ 6^{h}\cdot5$ *e*, $17^{d}\ 11^{h}\cdot4$ *e*, $26^{d}\ 4^{h}\cdot4$ *m*.

Rhea (every second given). November $3^{d}\ 7^{h}\cdot6$ *m*, $12^{d}\ 8^{h}\cdot3$ *m*, $21^{d}\ 8^{h}\cdot9$ *m*, $30^{d}\ 9^{h}\cdot6$ *m*.

For Titan and Iapetus, E. W. mean East and West elongations, I., S. Inferior and Superior Conjunction, Inferior being to the North, superior to the South. Titan, $4^{d}\ 1^{h}\cdot4$ *m* W., $7^{d}\ 11^{h}\cdot7$ *e* S., $12^{d}\ 2^{h}\cdot7$ *m* E., $16^{d}\ 3^{h}\cdot1$ *m* I., $19^{d}\ 11^{h}\cdot0$ *e* W., $23^{d}\ 9^{h}\cdot2$ *e* S., $27^{d}\ 12^{h}\cdot0$ *e* E. Iapetus $12^{d}\ 3^{h}\cdot6$ *e* E.

URANUS is an evening Star, semi-diameter 2″. It is $7\frac{1}{2}°$ South of Alpha Capricorni, 5° South-West of Beta.

NEPTUNE is a morning star, not yet very well placed.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Nov. 1	43	22	Slow, bright.
.. 2	58	9	Slow, bright.
.. 10–12	133	51	Very swift, streaks.
.. 14–16	150	22	Leonids, swift, streaks.
.. 16–28	154	41	Swift, streaks.
.. 20–23	63	23	Slow, bright.
.. 17→23	25	43	Andromedids, very slow,
.. 25 to Dec. 12	180	73	Rather swift. [trans.
.. 30	100	58	Swift, streaks.

CLUSTERS AND NEBULAE.

Name.	R. A.	Dec.	Remarks.
H II. 224	$1^{h}\ 4^{m}$	N 35 ·2	Faint nebula.
M. 33	1 28	N 30 ·2	Large faint nebula.
M. 76	1 37	N 51 ·1	Double spiral nebula.
H VI 31	1 40	N 60 ·7	Cluster.
H VI 33, 34	2 13	N 56 ·7	Fine double cluster.
H. 227	2 27	N 57 ·2	Cluster.
H I 156	2 35	N 38 ·7	Bright nebula.
M. 34	2 37	N 42 ·4	Cluster.

DOUBLE STARS.—The limits of R.A. are 1^{h} to 3^{h}.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
ζ Piscium	1 9	N 7 ·1	4, 5	64°	23″	Yellow.
42 Ceti	1 15	S 1 ·0	6, 7	358	$1\frac{1}{2}$	White, bluish.
ψ Cassiopeiae	1 20	N 67 ·7	4, 8	110	25	Yellow, bluish.
Each Star has a faint companion distant 3″						
Polaris	1 25	N 88 ·8	2, 9	217	18	Yellow, white.
Lalande 3137 ...	1 37	S 11 ·7	5, 7	87	4	White, bluish.
Piazzi I. 179 .	1 45	N 21 ·0	6, 7	164	3	Gold, blue.
γ Arietis	1 49	N 18 ·9	4, 4	359	8	Yellowish, bluish.
Piazzi I. 209 ...	1 51	N 1 ·4	7, 7	30	1	White, period 130 years.
α Piscium . . .	1 57	N 2 ·4	3, 5	318	3	Yellowish, greenish.
γ Andromedae	1 58	N 41 ·9	2, 5	62	10	Orange, emerald.
The companion is a close double, period 55 years.						
ι Trianguli	2 7	N 29 ·9	5, 6	75	4	Yellow, blue.
ι Cassiopeiae ...	2 22	N 67 ·0	4, 7	243	2	Yellow, blue.
There is also an 8th magnitude star, distant 7″						
ν Ceti	2 31	N 5 ·2	5, 9	83	8	Yellow, ash.
84 Ceti	2 37	S 1 ·0	6, 9	318	4	White, purple.
γ Ceti	2 39	N 2 ·9	3, 7	291	3	Yellow, blue.
π Arietis	2 44	N 17 ·2	5, 8	121	3	Yellowish, orange.
Piazzi II. 220	2 55	N 52 ·0	5, 7	85	12	Bluish, greenish.
ε Arietis	2 54	N 21 ·0	5, 6	202	1	White.

TABLE 45.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

TABLES OF JUPITER'S SATELLITES.—There was an unanswered query in "KNOWLEDGE" some months ago, inquiring how the configuration of Jupiter's satellites could be obtained for other times than those given in *The Nautical Almanac*. If one neglects the mutual perturbation of the satellites, the problem is not a difficult one. Some simple tables have appeared in the *Boletin de la Sociedad Astronomica de Mexico* for June and July last, by Senor Enzo Mora. I think that the portion of these tables that is required for giving the *abscissa* of each satellite (*i.e.*, the apparent distance east or west of Jupiter's centre in terms of the planet's equatorial radius) will be of interest to a sufficient number of our readers to justify its reproduction here. The time for which the positions are required is to be expressed in Greenwich Mean Time (Day commencing at noon, as is the usage in astronomical reckoning). Then the six quantities, I, II, III, IV, m, n, are to be found by adding the quantities from the tables A_1, A_2, A_3, A_4, A_5, with arguments century, year of century, month, day of month, hour.

TABLE A_1.

Century Figure	I	II	III	IV	m	n
16 (1600 to 1699) ...	35	203	287	775	303	711
17 (1700 to 1799) ...	690	801	857	850	869	141
18 (1800 to 1899) ...	345	401	429	925	434	571
19 (1900 to 1999) ...	0	0	0	0	0	0
20 (2000 to 2099) ...	221	881	711	135	569	429
21 (2100 to 2199) ...	876	481	283	211	135	858

TABLE A_2.

Year of Century	I	II	III	IV	m	n
00	104	973	658	54	755	640
01	335	672	590	840	670	724
02	566	370	523	626	585	809
03	797	69	455	413	501	893
04	593	49	527	259	418	977
05	823	747	459	45	333	62
06	54	446	391	832	248	146
07	285	144	323	618	163	230
08	81	124	395	464	81	315
09	312	822	327	251	996	399
10	543	521	259	37	911	483
11	774	219	192	824	826	567
12	570	199	263	670	744	652
13	801	897	196	456	659	736
14	32	596	128	243	574	820
15	263	294	60	29	489	905
16	59	274	132	875	406	989
17	290	973	64	661	321	73
18	521	671	996	448	236	157
19	752	370	928	234	151	242
20	548	349	0	80	69	326
21	779	48	932	867	984	410
22	10	746	865	653	899	495
23	241	445	797	440	814	579
24	37	425	869	286	732	663
25	267	123	801	72	647	748
26	498	822	733	859	562	832
27	729	520	665	645	477	916
28	525	500	737	491	394	1
29	756	198	669	278	309	85
30	987	897	602	64	225	169
31	218	595	534	850	140	253
32	14	575	606	697	57	338
33	245	274	538	483	972	422
34	476	972	470	269	887	506
35	707	670	402	56	802	591
36	503	650	474	902	720	675
37	734	349	406	688	635	759
38	966	47	339	475	551	844
39	197	746	271	262	467	928
40	993	726	343	108	384	12
41	223	424	275	894	299	97
42	454	123	207	681	214	181
43	685	821	139	467	129	265
44	481	801	211	313	47	350
45	712	499	143	100	962	434
46	943	198	75	886	877	518
47	174	896	8	673	792	602
48	970	876	79	519	710	687
49	201	574	12	305	625	771
50	432	273	944	92	540	855
51	663	971	876	878	455	940
52	459	951	948	724	372	24
53	690	650	880	510	287	108
54	921	348	812	297	202	192
55	152	47	744	83	117	277
56	948	26	816	929	35	361
57	179	725	748	716	950	445
58	410	423	681	502	865	530
59	641	122	613	289	780	614
60	437	102	685	135	698	698
61	667	800	617	921	613	783
62	898	499	549	708	528	867
63	129	197	481	494	443	951
64	925	177	553	340	360	36
65	156	875	485	127	275	120
66	387	574	418	913	191	204
67	618	272	350	699	106	287
68	414	252	422	546	23	373
69	645	951	354	332	938	457
70	876	649	286	118	853	541
71	107	347	218	905	768	626
72	903	327	290	751	686	710
73	134	26	222	537	601	794
74	366	724	155	324	517	879
75	597	423	87	111	433	963
76	393	403	159	957	350	47
77	623	101	91	743	265	132
78	854	800	23	530	180	216
79	85	498	955	316	95	309
80	881	478	27	162	13	385
81	112	176	959	949	928	469
82	343	875	891	735	843	553
83	574	573	824	522	758	637
84	370	553	895	368	676	722
85	601	251	828	154	591	806
86	832	950	760	941	506	890
87	63	648	692	727	421	975
88	859	628	764	573	338	59
89	90	327	696	359	253	143
90	321	25	628	146	168	227
91	552	724	560	932	83	312
92	348	703	632	778	1	396
93	579	402	564	565	916	480
94	810	100	497	351	831	565
95	41	799	429	138	746	649
96	837	779	501	984	664	733
97	67	477	433	770	579	818
98	298	176	365	557	494	902
99	529	874	297	343	409	986

TABLE A_1.

Month	I	II	III	IV	m.	n
Jan., common year ...	664	399	767	478	848	986
Jan., leap year	99	118	628	419	846	986
Feb., common year ...	180	122	93	329	928	994
Feb., leap year	615	840	953	269	926	993
March ...	0	0	0	0	0	0
April	516	722	326	850	78	7
May	460	163	512	641	152	14
June	981	886	838	491	227	21
July	932	327	24	282	300	28
August ...	447	49	350	132	375	35
September ...	963	771	675	983	451	42
October ...	913	212	862	773	526	49
November ...	429	935	187	624	605	57
December ...	379	376	374	414	683	63

TABLE A_2.

Day of Month	I	II.	III	IV	m	n
1	0	0	0	0	0	0
2	565	281	140	60	3	0
3	130	563	279	119	5	0
4	695	844	419	179	8	1
5	260	125	558	239	10	1
6	825	407	698	298	13	1
7	390	688	837	358	15	1
8	955	970	977	418	18	2
9	520	251	116	478	20	2
10	85	532	256	537	23	2
11	650	814	395	597	25	2
12	215	95	535	657	28	3
13	780	376	674	716	30	3
14	345	658	814	776	33	3
15	910	939	954	836	35	3
16	475	220	93	895	38	3
17	40	502	233	955	40	4
18	605	783	372	15	43	4
19	170	65	512	74	45	4
20	735	346	651	134	48	4
21	300	627	791	194	50	5
22	865	909	930	253	53	5
23	430	190	70	313	55	5
24	995	471	209	373	58	5
25	560	753	349	433	60	6
26	125	34	489	492	63	6
27	690	316	628	552	65	6
28	255	597	768	612	68	6
29	820	878	907	671	70	6
30	385	160	47	731	73	7
31	950	441	186	791	75	7

TABLE A_3.

Hour of Greenwich Mean Time, Starting at Noon.	I	II	III	IV.	m	n.
0^h	0	0	0	0	0	0
1	24	12	6	2	0	0
2	47	23	12	5	0	0
3	71	35	17	7	0	0
4	94	47	23	10	0	0
5	118	59	29	12	1	0
6	141	70	35	15	1	0
7	165	82	41	17	1	0
8	188	94	47	20	1	0
9	212	106	52	22	1	0
10	235	117	58	25	1	0
11	259	129	64	27	1	0
12	283	141	70	30	1	0
13	306	152	76	32	1	0
14	330	164	81	35	1	0
15	353	176	87	37	1	0
16	377	188	93	40	2	0
17	400	199	99	42	2	0
18	424	211	105	45	2	0
19	447	223	110	47	2	0
20	471	234	116	50	2	0
21	494	246	122	52	2	0
22	518	258	128	55	2	0
23	541	270	134	57	2	0
24	565	281	140	60	3	0

The sums of the quantities from the above five tables are to be taken rejecting in the sum any integral number of thousands. Then apply to each of the sums I, II, III, IV, m the correction given in Table B, the argument being the sum of n just found; afterwards apply to the corrected sums I, II, III, IV the second correction given in Table C, the argument being the corrected sum of m. The second correction is

+ when m is less than 500.
— „ „ „ greater „ „

TABLE B.

n.	Correction	n	Correction.	n	Correction
0	15	350	3	700	30
50	10	400	7	750	31
100	6	450	11	800	30
150	2	500	15	850	28
200	0	550	20	900	25
250	0	600	24	950	20
300	1	650	27	1000	15

TABLE C.

m	Correction.	m	m	Correction	m
0	0	1000	260	30	740
20	+ 5	980	280	29	720
40	9	960	300	27	700
60	14	940	320	25	680
80	18	920	340	23	660
100	21	900	360	21	640
120	24	880	380	18	620
140	27	860	400	16	600
160	28	840	420	13	580
180	30	820	440	10	560
200	31	800	460	6	540
220	31	780	480	+ 3	520
240	31	760	500	0	500

Finally, the apparent distance of the satellites east or west of the planet's centre is found by the diagram, the unit of distance being the planet's equatorial radius. The sums I, II, III, IV, are in units of one-thousandth of the circumference. They may be reduced to degrees by multiplying by 0·36.

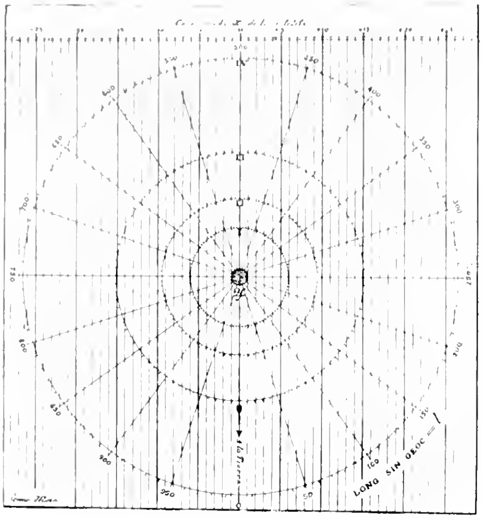


FIGURE 424.

If I, II, III, IV denote their values in degrees, we may instead of using the diagram find the distances from Jupiter by the equations.

Distance of	I	5·93 sin I
„	„ II	9·44 sin II
„	„ III	15·06 sin III
„	„ IV	26·49 sin IV

Satellites are west of Jupiter when their angle is less than 500, or 180° after reducing to degrees. The original tables contain a correction for light-time, but I have omitted this. The quantities given here are for a mean light-time. The tables also enable us to find the times of conjunction or opposition of Jupiter. These phases occur when m is 500 and 0 respectively. For example to find when Jupiter is in opposition in 1913.

	Arg.	m.	n
Table A_1	19	0	0
„ A_2	13	659	736
„ A_3	July	300	28
„ A_4	17	40	4
Sum	—	999	768
Correction Table B	768	31	—
Corrected m... ...		30	

And since m increases thirty in twelve days (Table A_3), we must go twelve days earlier to obtain the date of opposition, which therefore occurs 1913, July 5th.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

SHORTENING OF WINTER-REST OF TREES.

In recent years much attention has been paid to methods of forcing based upon the awakening of activity in dormant plants by means of warm water or anaesthetics.

The etherisation of bulbous and other plants for the cut-flower trade has, largely owing to the experiments of Johannsen, been successfully employed with lilac, mimosa, lily of the valley, and so on, and has proved remarkably economical of time, space, and heat. The plants are exposed for a day or two in a tight box to an atmosphere of ether vapour, and after treatment are placed under conditions favourable for growth.

Gardeners have long known that placing the roots of plants in warm water tends to start into more rapid and certain growth dormant plants, especially when transplanting them. Molisch has described interesting results based upon the warm bath method of forcing, which consists essentially in immersing the plant or branch in water at a temperature of 30° to 35° C. for from nine to twelve hours, as a rule. When potted plants are used, it is preferable to invert the pot and immerse the stem only, since the roots are usually more sensitive to injury.

Jesenko (*Ber. deutsch. bot. Ges.*, XXX, 1912) has recently described a series of experiments with various trees and shrubs, in which different substances were used in order to shorten the normal resting-period. He obtained successful results with immersion in alcohol and various acids, besides water charged with carbon dioxide and plain water. He finds that solutions of alcohol and acids gave better results in the middle of the resting-period than towards its close, and that immersion in a strong solution for a short period has the same effect as immersion in a weak solution for a long period. It is suggested that the action of the solutions used is not due merely to a stimulus in the strict sense of the word, but that the solutions employed set up chemical processes in the plant exposed to them. This view is supported by various observations; for instance, good results were obtained by injecting the solutions into the twigs instead of immersing the latter in the solutions.

Burgerstein has published (*Progressus rei botanicae*, IV) a concise but useful summary of the various new methods used in forcing. After describing the anaesthetic and warm-bath methods, in connexion with the researches of Johannsen, Molisch, and Howard, he deals briefly with the forcing effects of frost and partial desiccation. He points out the apparently paradoxical results of these modern experiments, which show that the resting-period can be curtailed by cooling or by warming; by supplying the plant with warm water or by depriving it of water by placing it in warm dry air; or by treating it with narcotic vapours like ether or chloroform. He concludes by stating that practically nothing can be said at present in answer to the questions, *how* these various methods of treatment act upon the plastic substances of the plant, why it is easier to wake the plant up at an *early* stage in its "sleep" than at a later stage, and so on.

OPHIOGLOSSALES AND MARATTIALES.—Professor D. H. Campbell, of the Leland Stanford University, California, has kindly sent the present writer a copy of his recent great work on the lower ferns ("The Eusporangiatae": Carnegie Institution, Washington, 1911)—a fine quarto volume of two hundred and twenty-four pages, with thirteen beautiful plates and nearly two hundred text-figures.

For over twenty years, Professor Campbell has studied the Pteridophyta, or fern-alliance, and has published a large number of memoirs on these plants, as well as some on the liverworts, and his "Mosses and Ferns" is a standard work for the student of the Byrophyta and Pteridophyta. In this sumptuous volume on the "Eusporangiatae," he brings together a summary of the present state of knowledge concerning the small but important families, Ophioglossaceae and Marattiaceae, which are placed at the base of the fern series in the modern scheme of classification.

Until comparatively recent times it was held that the ferns in which the sporangium is developed from a single cell ("Leptosporangiatae") gave rise to those in which the sporangium comes from a group of cells ("Eusporangiatae"), on the ground that in this character at any rate the former were simpler. It was held that the fertile spike of *Ophioglossum* arose by fusion of numerous small sporangia, and by further reduction and contraction the cone of Lycopods was derived from the same ancestry. The revolt against this view was led by Campbell himself, and the opposite position is now accepted. In his great series of memoirs on the Pteridophyta in the *Philosophical Transactions*, Bower showed that the terms "eusporangiate" and "leptosporangiate" must be abandoned as the names of groups, though useful in a purely descriptive sense. In Bower's classification, the small family Ophioglossaceae is separated, as Ophioglossales, from the remaining ferns which are classed as Filicales. The Filicales are divided into three main groups of families according to the characters of the sporangial clusters (sori) and of the sporangia themselves, the three groups being termed "Simplices," "Gradatae," and "Mixtae." In the Simplices (including Marattiaceae, Osmundaceae, and others) the sporangia of a sorus arise simultaneously; the mechanism for dehiscence of the sporangium is slightly developed, and the spore-output per sporangium is large. In the Gradatae (Hymenophyllaceae, Cyatheaceae, and others) the sporangia are produced on a more or less elongated rod-like placenta, and are developed on this in basipetal order (the oldest above, the youngest below), while the dehiscence mechanism is well-developed and the spore-output is smaller than in the Simplices; in the Mixtae, the sporangia of a sorus arise in no definite order; hence the sorus contains sporangia of various ages mingled together, the mechanisms for dehiscence and usually also those for protection of the sporangia are more perfect, and the number of spores per sporangium is usually restricted to sixty-four or sometimes forty-eight.

Campbell, however, points out in his memoir that the isolation of the Ophioglossaceae, as Ophioglossales, on one hand, and the inclusion of Marattiaceae with the remaining ferns in the Filicales, on the other, hardly do justice to the close affinities that exist between the Ophioglossaceae and the Marattiaceae. The author's detailed and skilful presentation of the facts of structure and development in these two families make this one of the most important botanical memoirs published in recent years. In the case of each family, he describes and compares the structure and development of the several genera, dealing in turn with the germination of the spore, the prothallus and sexual organs, the embryo, and the young and adult stages of the sporophyte, thus completing the life history.

The greater part of the volume is based upon the author's own work, the material for which has chiefly been collected by himself in various parts of the Tropics. In the case of every form worked at, various gaps in former accounts have been filled, the result being that we have here perhaps a more complete picture than exists at present for any other group of the higher plants. After a survey of the morphology of the two families, the author brings out clearly the strength of the links connecting these families. On various grounds he concludes that of the three genera of Ophioglossaceae, ***Ophioglossum*** is decidedly the most primitive, while ***Helminthostachys*** on the whole comes nearest the Marattiaceae, the simplest and presumably most primitive genera of the latter family being *Kaulfussia* and *Danaea*, while *Marattia* and *Angiopteris* are the most specialised.

The author believes that from some form allied to the simpler existing species of *Ophioglossum* the whole fern series has arisen; that in this whole series the leaf is the predominant organ, the stem at first being of quite subordinate importance; that this ancestral fern was one-leaved, the leaf being at first a fertile (spore-bearing) structure, perhaps without any definite sterile segment; and that from this central type several lines diverged, of which only a few fragments persist.

SCOTTISH PEAT DEPOSITS.—During the last seven years F. J. Lewis has published the results of his elaborate investigation of the plant-remains in the peat deposits of Scotland, and in his concluding paper (*Trans. Roy. Soc. Edinburgh*, XLVII) he gives a summary of the sequence of the layers found in these deposits, as follows:—

1. *First Arctic Bed*, probably corresponding to Geikie's Fourth Glacial Stage, with ice-sheets and valley glaciers, arctic climate with snow-line from one thousand to one thousand five hundred feet; in the Hebrides and Shetlands the beds contain dwarf willows, birch, crowberry, various temperate water-plants, and so on.

2. *Lower Forestian*, Fourth Interglacial Stage, consisting of forest overlying morainic accumulations of the Fourth Glacial Stage, genial climate, land area of greater extent than now; the buried forests, seen in the southern uplands as well as in the Hebrides and Shetlands, contain birch, hazel, and alder—showing that the now treeless West Shetlands had a calm and genial climate.

3. *Lower Peat Bog*, with *Sphagnum*, cotton-sedge, *Molinia*, and so on, and in the lower layers also *Phragmites*, *Equisetum*, *Menyanthes*.

4. *Second Arctic Bed*, widely distributed, with willows, crowberry, *Loiseleuria*, *Arctostaphylos alpina*, birch, *Lychnis alpina*, and so on.

5. *Upper Peat Bog*, still more widely spread, and similar to the lower bog in general characters. The Lower and Upper bogs, with the intervening Second Arctic Bed, probably answer to Geikie's Fifth Glacial or Lower Turbarian Stage of valley-glaciers, with average snow-line at about two thousand five hundred feet, and cold, wet climate.

6. *Upper Forestian*, or Fifth Interglacial Stage; in the south this upper forest consists chiefly of Scots pine, replaced in the north and at high altitudes by birch, and extends to over one thousand feet higher than the present limit of trees; the climate was relatively dry and genial.

7. *Recent Peat*, Sixth Glacial or Upper Turbarian Stage, with high level glaciers, snow-line at three-thousand five hundred feet, climate rather cold and wet.

LIFE HISTORY OF *PYRONEMA*.—A large amount of cytological work has been done on the Ascomycetes since Harper showed, in 1895, that in the mildew *Sphaerotheca castagnei* two nuclear fusions occur in the life-cycle—the first in the female cell or oögonium and the second in the young ascus. In 1900 (*Ann. Bot.*) Harper published a long paper based largely on his work with the small ascomycetous fungus *Pyronema confluens*, in which he claimed that the nuclei of the antheridium and oögonium—the male and the female nuclei—fuse in pairs, the fusion-nuclei passing into the ascus-producing threads; in the young ascus, as in *Sphaerotheca*, a second nuclear fusion occurs, preceding the division into the eight nuclei of the developing ascospores. A voluminous and somewhat controversial literature has resulted from the extension of this line of work to other fungi.

Claussen has now (*Zeitschr. für Bot.*, 1912) published an elaborate paper, beautifully illustrated by six double plates, on the life history of *Pyronema confluens*, together with a critical commentary on the results of other workers. He finds that the male nuclei enter the oögonium and pair with the female nuclei, though no fusion occurs between the paired nuclei. These pass out into the ascogenous hyphae and there undergo division, still remaining paired but not fused. Finally, the descendants of these nuclei fuse in the young ascus. In the young ascus there is a pair of nuclei, one male and the other female, and these divide into a paired nucleus for the ascus and two reserve nuclei; the paired nuclei fuse, giving one nucleus, and this divides with reduction of chromosomes (heterotypic division). Hence, in the life cycle there is a single fusion and a single reduction division. The sporophyte generation, represented by the ascogenous hyphae, is therefore not sharply separated from the gematophyte generation; its nuclei are paired, the double number of chromosomes being present in the coupled nuclei and not in a single nucleus. The young ascus represents the spore mother-cell, its fusion-nucleus containing as many double chromosomes as the gametophyte nuclei contain single ones. A similar pairing of sexual nuclei, without fusion until a relatively late stage in the life cycle, occurs in the Uredineae, as shown by Blackman and others.

PHYSIOLOGY OF TREES.—Some interesting results have recently been obtained by Ramann and Bauer (*Jahrb. für wiss. Bot.*, 1911) from investigations on a large scale of the changes in dry-weight and ash-composition in the saplings of a number of trees. In spring, during the expansion of the leaves, there is a loss of from twenty to forty-five per cent. of the total dry weight in the case of deciduous trees. This remarkable result emphasises the great expenditure of energy and material during growth. In the case of coniferous trees, however, there is a much smaller loss, or even a small gain, which may be explained by the fact that these trees are able to make new food by means of their old leaves, at an early period in spring, and thus make good the loss by respiration during the opening of the buds. It is suggested that in spring the abundance of soil-water and stored food lead to a sort of temporary overfeeding in deciduous trees, and to this they consider the large-celled character of the spring-wood is related. The second outburst of growth which often occurs later in the year, is also caused frequently by abundant supply of water, and in this case also a ring of "spring" wood is produced. In pines growing on rich low-lying moors, the wood is practically all of the same character as the spring wood; in such a habitat water and food-substances are abundant throughout the growing season.

From extensive ash analyses it was found that, excepting in the conifers, practically no nitrogen was absorbed during the spring, while the leaves were expanding. The time of maximum absorption of nitrogen varies according to the species, then falls off in late summer; in the Alder, owing to the presence of the root-nodules with their nitrogen-fixing bacteria, the absorption of nitrogen continues steadily from May to November. The time of maximum absorption of each of the elements—potassium, calcium, magnesium and phosphorus—varies in different species; while in the same species the various elements are absorbed at different times and at rates which vary independently. For instance, the pine absorbs nitrogen most rapidly in June, calcium in August.

Zon and Graves (*U.S. Dept., Agric., Forest Service Bulletin No. 92*, 1911) have studied the influence of light on the growth of trees. Their admirable memoir deals with the different kinds of light—direct, diffused, overhead, lateral, reflected. Diffused light is the most important, but some trees need direct as well as diffused light, either during their whole life or at the time of leafing and of flowering. A table is given showing the decrease of direct and diffused light with increase of latitude, direct light decreasing most until at the poles it is zero, whereas diffused light is 20; at the equator direct light is 489 as against 227 for diffused light. The authors also discuss the variation of direct and diffused light quantities with altitude, and the minimum light needed for various trees, but the greater part of their paper is devoted to the question of shade-tolerance, or the ability of trees to endure shade, and the way in which this tolerance is influenced by climate, altitude, soil moisture, soil fertility, and the age and vigour of the tree. The methods of determining tolerance are discussed under three headings: (1) empirical methods—observations on density of the crown, amount of branching, and so on; (2) anatomical and physiological methods—minute structure and assimilation capacity of the leaves; (3) physical methods—measurement of luminous and chemical light intensities.

Preston and Phillips (*Forestry Quarterly*, 1911) have enquired into the nature and variation of the reserve food materials in certain American trees, comparing their results with those obtained by European investigators. Starch seems to be the chief reserve food, and in temperate climates a great reduction in its amount occurs during the first weeks of winter, though there is no great increase in the amount of sugar except at the unfolding of the buds in Spring. The maximum for reserve starch in deciduous trees appears to be at the period of leaf fall, while in evergreens it is at the opening of the buds in Spring.

CHEMISTRY.

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

RED PHOSPHORUS.—The *Berichte* of the German Chemical Society (1912, XLV, 1514) contains an interesting account of experiments made by Messrs. Stock, Schrader and Stamm upon the conditions for converting ordinary phosphorus into the red modification by means of radiation. The influence of red rays and ultra-violet rays was very slight, the greatest effect being produced by visible rays in the violet part of the spectrum. When exposed to radiations of a mercury-vapour lamp or an induction spark the phosphorus changed through yellow to red and subsequently became opaque, probably owing to the coagulation of the colloidal solutions first formed.

The red phosphorus formed under the influence of radiation ignited at 130°—140° C., ordinary phosphorus probably being produced before ignition. The darker the specimen the greater was its specific gravity, which ranged from 1·95 to 2·25; and considerable differences were also observed in the various preparations as regards the rate with which they would combine with oxygen. Apparently they were all amorphous in structure.

When ordinary phosphorus vapour was heated to a temperature of about 1000° C. and then suddenly cooled it yielded an amorphous red modification, whereas when the cooling was done slowly there was no such change. The explanation suggested is that the high temperature causes dissociation of the P_4 molecules, and that the sudden chilling causes the resulting smaller molecules to combine together or with undissociated P_4 molecules to produce a red modification.

This phosphorus is red and transparent in thin layers, but appears violet-black in large masses. It has a somewhat lower specific gravity than ordinary red phosphorus, and is also more permanent when exposed to the air. It also offers great resistance to the action of boiling sodium hydroxide solution.

CHEMICAL REACTIONS AT HIGH PRESSURES.—An apparatus has been devised by Dr. F. Bergius (*Zeit. angewan. Chem.*, 1912, XXV, 1171), for studying the process of chemical reactions under pressures maintained at over one hundred and fifty atmospheres for several weeks and at high temperatures (300° to 400°C.). Under these conditions carbon will react with water at 350 C., in the presence of a catalytic agent, with the formation of hydrogen and carbon dioxide. Aromatic hydrocarbon hydroxyl derivations, such as naphthol and phenol were obtained in the same way at a pressure of one hundred atmospheres by the interaction of solutions of alkalies upon the corresponding hydrocarbon chlorine derivative; while oxygen could be made to combine directly with calcium oxide to form calcium peroxide.

But perhaps the most interesting reaction was the production of an artificial coal of very similar composition to natural coal. This was obtained by heating either peat or cellulose with water to about 340°C. at a high pressure. This method also seems likely to throw light upon the mode of formation of petroleum and its derivatives.

DISTRIBUTION OF NITROGEN IN WHEAT.—A series of estimations of the distribution of nitrogen in the different parts of the wheat grain has been made by Messrs. Greaves and Stewart (*Journ. Agric. Science*, 1912, IV, 376), the wheat being ground in a small experimental mill. From the results obtained with fifty-eight different varieties the conclusion is drawn that the amount of nitrogen in the whole wheat does not afford a measure of the quantity that will be left in the flour. Thus, the proportion of proteins in the flour ranged from 56·84 to 65·56 per cent. of that originally present in the grain, while the proportion in the bran showed variations of 25 to 32·7 per cent. Wheats rich in protein yielded flours containing no more nitrogen than those that contained relatively little protein. From the average results obtained with forty-two varieties of wheat it was calculated that the proteins were distributed between the flour, bran and "shorts" in the respective proportions of 61·87, 27·98 and 9·92 per cent.

DRYING OF YEAST.—Hitherto processes used for drying yeast have inevitably caused the destruction of a large proportion of the living cells and the dried product has had much lower enzymic activity than the fresh yeast. In a process recently described by Herr Hayduck (*Zeit. angewan. Chem.*, 1912, XXV, 1179) this drawback is overcome and dried yeast with ninety per cent. of its cells alive is obtained.

The yeast is first suspended, for two or three days, in water through which a current of air is passed, the effect of this being to alter the proteins of the cells in such a way that they may be subsequently dried without injury. Another process is also used, in which the yeast is pressed, mixed with sugar and dried at a temperature of 50°C.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

THE NEW MADRID EARTHQUAKE.—The succession of shocks designated collectively the New Madrid earthquake began on December 16th, 1811, in an area of the Central Mississippi valley, and lasted for more than a year. For continuity of disturbance, area affected, and severity, this series of shocks deserves a place among the great earthquakes of the world. Scientifically, this earthquake, occurring in a low-lying alluvial region, may be regarded as a type exhibiting in unusual detail the geological effects of great disturbances upon unconsolidated deposits. Even after the lapse of a century the effects of the earthquake may still be studied. A systematic record of the phenomena is made, for the first time, by M. L. Fuller, in Bulletin 494 of the United States Geological Survey. The effects of the initial earthquake of the series are thus graphically described:—"The ground rose and fell as earth waves, like the long, low swell of the sea, passed across its surface, tilting the trees until their branches interlocked, and opening the soil in deep cracks as the surface was bent. Landslides swept down the steeper bluffs and hillsides; considerable areas were uplifted, and still larger areas sunk and became covered with water emerging from below through fissures or little 'craterlets,' or accumulating from the obstruction of the surface drainage. On the Mississippi great waves were created, which overwhelmed many boats and washed others high upon the shore, the return current breaking off thousands of trees and carrying them out into the river. High banks caved and were precipitated into the river, sand bars and points of islands gave way, and whole islands disappeared." Fortunately the area was very thinly settled; and the houses, for the most part built of logs, did not collapse suddenly, but gave the inhabitants sufficient warning for them to escape. Hence there was only a slight loss of life.

A remarkable feature of the earthquake was the formation of long canal-like depressions, which appear in reality to be narrow, down-faulted blocks between two parallel cracks. Similar fissuring in the river banks and in the higher bluffs bordering the Mississippi lowlands resulted in great landslides. A regional warping of the surface also occurred, giving rise in some places to broad dome-like lifts; in others to depressions, now mostly occupied by peculiarly-shaped lakes, such as Reelfoot Lake, Tennessee. Many of these lakes contain trees still standing, but killed by the century-old submergence. Some striking photographs help the reader to realise the clearness with which the effects of this earthquake may still be traced.

METEOROLOGY.

By John A. Curtis, F.R.Met.Soc.

The weather of the week ended July 20th, as set out in the Weekly Weather Report issued by the Meteorological Office, was fair and dry at first, but became unsettled over England generally, and rain was experienced in most localities. Thunder was heard on the 14th, and there was a thunderstorm at Alnwick Castle on the 20th. Temperature was above the average in all districts except England, N.E., and Ireland, N. The greatest excess was 4°·3 in England, S.W. Maxima exceeding 80° were observed in all districts except Scotland, N., and in Ireland. The highest reading was 90° at Camden Square on the 15th, with 88° at Greenwich, Tottenham, Bath and Clifton. The lowest of the minima were 37° at Kilmarnock, and 38° at Balmoral, West Linton and Marlborough. On the grass the temperature fell to 33° at Marlborough and at Wisley. The temperature of the soil, both at one foot and at four feet was above the average.

Rainfall was greatly in defect very generally. The only district where the amount collected was in excess was England, N.E., where it was 0·19 inch above normal. In Scotland, E., and England, N.W., the week was almost rainless. At only one station in the United Kingdom did the total rainfall for the week amount to one inch or upwards, namely, at Alnwick Castle, 1·63 inches. Sunshine was in excess except in Scotland, E., and England, N.E. The defect of 0·3 hours daily (2%) in Scotland, E. is noteworthy in face of the fact that the rainfall in that district was only 0·01 inch or 0·72 inch below the average.

The mean temperature of the sea water round the coast varied from 52°·2 at Lerwick to 67°·4 at Margate.

The weather of the week ended July 27th was mostly unsettled and rainy, with frequent thunderstorms. Temperature was below the average in Scotland, E., England, N.E., Ireland and the English Channel, but above it elsewhere. The greatest variation was in England, E., where the mean, 63·1, was 2°·4 above the normal. The maxima were much lower than in the previous week, and exceeded 80° only at Greenwich (82°), and at Camden Square (81°) on the 24th, the next highest reading being 79° at Margate on the same day.

In Ireland, N., the highest reading was only 68°. The lowest readings of the week were 31° at Balmoral on the 23rd, and 35° at Glencarron on the 25th. The lowest readings on the grass were 29° at Balmoral and 34° at West Linton.

The temperature of the soil did not differ much from the average.

Rainfall was in excess except in Scotland, N. and W., and in England, S.E. In many cases the excesses were large, and in Ireland, S., the total was three and a half times the usual amount. At each station in this district rain fell on each day, and the total collected at Cahir was 3·94 inches.

Sunshine was in defect in all districts, by as much as 3·7 hours per day (23%) in England, N.E., and 4·0 hours per day (27%) in the English Channel. In seven districts, namely, Scotland, E., England, N.E. and S.W., Midland Counties, the English Channel and Ireland, N. and S., the amount of sunshine was less than half the normal.

The mean temperature of the sea water was, as a rule, above the average, and varied from 52°·4 at Lerwick to 65°·6 at Eastbourne.

The weather of the week ended August 3rd was very dull and wet, with many thunderstorms. At Alnwick Castle very large hail fell on the 29th of July.

Temperature was below the average at every station. The district values were in defect by amounts varying from 3°·1 in England, E., to 5°·8 in Ireland, S. The highest readings reported were 72° at Greenwich, 71° at Camden Square, and 70° at Scarborough, Yarmouth and other stations. The lowest readings were 30° at Llangammarch Wells, 31° at West Linton and 33° at Markree Castle. On the grass the temperature fell below the freezing point at many stations, the lowest reading reported being 25° at Birmingham. The temperature of the soil at one foot depth was below the normal; but at a depth of four feet the readings were mostly above the average. Rainfall was in excess in all districts; very greatly so in some. In England, N.W., and S.W., and in the English Channel, the total collected was more than three times as much as usual. Sunshine was in defect in all districts and the average daily duration varied from 2·6 hours in Scotland, E., and England, N.E., to 5·8 hours (39%) in the English Channel.

The temperature of the sea water varied from 49° at Lamlash to 66° at Eastbourne.

The weather for the week ended August 10th, was again very inclement, being dull, cold and wet, with many thunderstorms.

Temperature was in defect in all districts, by as much as 5°·9 in Ireland, S. In this district the mean temperature, and also the maximum and minimum, were lower than the corresponding values in Scotland, N.

The highest readings reported were 73° at Greenwich and Camden Square, 72° at Margate, and 71° at Norwich and

Cambridge. None of the minima were, however, below the freezing point, the lowest being [illegible] at Markree Castle and [illegible] at Kilkenny and Balmoral. On the grass also, no readings below freezing point were reported, the lowest of the radiation temperatures being 32° at Markree Castle and 33° at Dublin and Crathes.

The temperature of the soil, both at one foot and four feet depth, was below the average.

Rainfall was in excess in all districts, and in some parts by considerable amounts. In Scotland, E., [illegible], S.W., and the English Channel, the total was about three times as much as usual. Sunshine was in defect at every station, and in Scotland, E., the mean daily amount was only 0·8 hours, as compared with an average of 4·9 hours, or one-sixth of the usual amount.

The mean temperature of the sea water round our coasts ranged from 52·7 at Berwick to 63·2 at the Shipwash light vessel.

OCEAN WAVES.—In the monthly meteorological chart of the Indian Ocean and Red Sea for August, some very interesting particulars are given of high ocean waves. It appears that the abnormally high solitary sea is the most dangerous, and that these are not confined to tropical seas, but are occasionally met with near our own coasts. Thus, in 1897, at the entrance to the English Channel, the steamship "Millfield" encountered a sea which washed overboard the upper bridge, the funnel and the boats, and had her fires extinguished by eight feet of water, which entered by the openings on deck.

Another case mentioned is that of the "Brandenburg," which shipped a tremendously high wave, estimated at sixty-five feet in height, which stove in the crow's nest constructed of quarter inch steel plating at fifty feet above sea level!

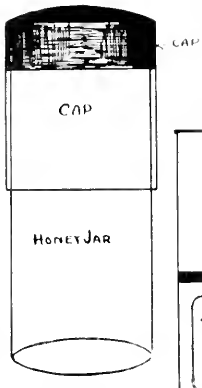


Figure 425.

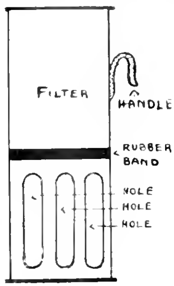


Figure 426.

MICROSCOPY.

By F.R.M.S.

A NEW POND COLLECTING APPARATUS.

For collecting pond and marine life it is necessary to have some appliance which shall be simple, efficient, portable, and if possible, cheap and easy to clean. The first three or four of these requirements are obviously essential and desirable, but the last also is an essential as we may on one occasion be studying ordinary pond life, on another it may be marine life, whilst on yet another we may be engaged in examining the vegetable or bacterial organisms existing in, say, a filter bed or its effluent. This last is a most important department of research, and requires considerable care if reliable results are to be obtained. Many, indeed, use the ordinary Wright's bottle, which, however effective in most cases, is of but little use when bacterial life is abundant. Others use a funnel plugged with cotton wool, but this soon gets clogged with the fine ooze which predominates in a filter bed.

A very simple and inexpensive arrangement may, however, be contrived which answers well not only in all ordinary cases, but also for collecting even such minute organisms as diatoms and bacteria. The use of it for some time compels the author to give the whole his warm recommendation as fulfilling every requirement (see Figure 425).

It consists of three parts, the first of these being a common honey bottle six inches long by two in internal diameter. The kind I use is called Gray's Honey jar which is of the same internal diameter throughout and can be purchased at Mr. George Rose's, 30, Bolton Street, Liverpool, at the cost of twopence each. Half a dozen of these should be obtained, costing with postage about eighteenpence. They are portable, which cannot be said of the ordinary collecting bottle, and three or four can easily be carried in the coat pockets. They are fitted with a good cork wad and a screw cap which secures the contents perfectly without any leakage—an advantage of some value when investigating sewage life.

Over the cap fits loosely a tin cup about two or three inches deep, and just wide enough to go freely over the cap or bottom of the jar. It has no handle, and only one is needed even if we carry more than one honey jar on our expeditions. It is obviously easy to clean. It may, however, be dispensed with altogether if required. Mine cost sixpence at the tinman's. The top is "wired," not left sharp (see Figure 426).

The filtering apparatus itself, upon which the efficiency of the whole depends, consists of a simple tin tube, five inches long by one and three-quarter inches external diameter. It is open at both ends, which are both wired. On the lower half numerous slots or circles are cut about half an inch in diameter, as shown in the diagram. A piece of curved spring is soldered to the side, and the whole should be of such a diameter as to fit without stiffness into the honey jar. Over the bottom, about three inches up the sides, is stretched a piece of the finest silk gauze, or better still, a piece of what is known as 160 bolting silk, which can be obtained at Messrs. C. Baker's in Holborn, and doubtless of other opticians. For bacteria and diatoms this may be replaced by a bit of fine Japanese undyed silk. An indiarubber band (mine is made from an old bicycle inner tube) securely fastens everything in place.

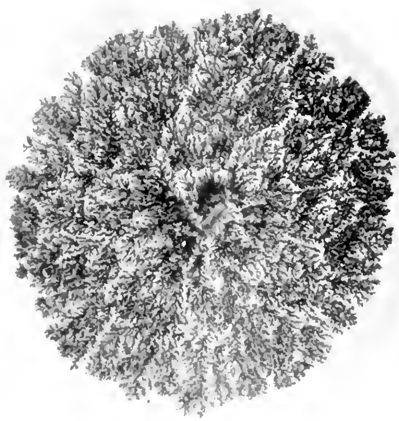


Figure 427.

Thus equipped we go forth, and on arriving at the scene of operations, remove the cup and cap and draw out the filter, which we suspend by its hook so as to hang *outside* the jar. We then proceed to work, and by means of the cup fill the filter time after time, until we judge that enough has been gathered. We then empty the filter into the jar and recommence. It is, however, a great mistake to overcrowd the jar, and very cruel, too. A large amount of life is lost, and many rotifers will not work in such unnatural surroundings. When finished, unhook the filter, replace it in the jar, and put on the cap and cup after wiping the latter. As we have already said, the cup may be dispensed with, the filter being held in the one hand and the jar used as a ladle.

With care in the selection of the straining fabric, comparatively few living things will be lost, as they are not so crowded together as when passing down a narrow tube. The fabric may be washed and used several times, but it ought to be boiled before its use a second time. The whole answers almost every requirement of even the most exacting, and its cheapness is its smallest recommendation. The ordinary wire ring and gauze funnel with a small tube at the bottom is, as everyone knows who has used it, a mere inconvenient plaything, and for sewage effluents all but useless. This apparatus, simple as it is, answers all but every scientific requirement. It catches an exceedingly large proportion of bacterial organisms, and for ordinary pond life it is an almost perfect filter for very few creatures get through.

For marine life, one of a much larger size may be used and the dredge emptied into it, but in this case it is best made without openings in its side, and a wet string must go tightly round the bottom not less than three or four times and be securely fastened. One a foot wide and high is a good size. It need not have a hook on the side, as a bucket will, of course, be used into which to empty the filtrate. A quart enamelled jug makes a convenient ladle, and it must be remembered that marine life above all requires plenty of room, and that large glass *cloches* must be employed if an aquarium is not used. Finger glasses, which do well temporarily for pond life, are utterly inefficient for any marine gatherings except those derived from the small rock pools.

My own apparatus cost me thirteenpence. My old apparatus, which cost about five shillings, is now used as a pickling jar, a purpose for which it is seemingly far better fitted than that for which it was primarily designed. People no longer ask me whether I have been catching "minners," in fact they see nothing, not even a collecting stick, and hence one is looked upon as slightly more sane than heretofore—so easily are reputations for wisdom acquired. I am quite certain that once used the apparatus will never be replaced, at any rate not by any other at present in the market.

E. Ardron Hutton.

Figure 428.

SPOTS IN PHOTOGRAPHIC PRINTING PAPERS.—Objects of much interest to the microscopist are the minute metal spots which occur in various kinds of photographic papers, chiefly the printing-out varieties, coated with gelatino-chloride and collodio-chloride emulsions.

If the sensitiveness of a sheet of paper be removed by the usual fixing process and the surface examined under a low power—a one-inch objective is sufficient—one will frequently find a few spots embedded in or resting upon the film. The larger ones can be detected by unaided sight, but the more minute forms require optical assistance to locate them.

Many of the spots have no definite shape, but occasionally most beautiful designs occur consisting of a net-work of filaments, radiating from a dense nucleus. They are doubtless the result of crystallisation of one of the various metals entering into the composition of the emulsion—probably the silver—as the formation of the filaments bears some resemblance to the well-known shape of silver crystals.

Figure 429.

These "silver trees" are generally caused by metallic impurities in the paper itself as, in several cases, the nucleus was found embedded in the fibres on the surface; small particles of metal or other reducing agents might also occur in the baryta substratum upon which the emulsion is usually coated and, in any case, an action reducing the chloride to the metallic state would result.

The sizes of the spots are sometimes as large as two millimetres in diameter and the forms range from a few straggling branches to a vast network of beautiful design. Those produced upon the collodion film are characterized by the delicacy of the filaments which can be traced to the exact point in the nucleus where the action commenced; in the case of the gelatine film, the filaments are much thicker and the nucleus is generally a larger mass than in the collodion variety. The difference may be due to the dissimilarity of the gelatine and collodion or to a combination of metals forming the crystals.

Figure 430.

Figures 427 and 428 show types found in the collodion film, and are magnified eighty and fifty times respectively, the photographs being taken by reflected light, which is the best method of illumination for examining this variety.

Figures 429 and 430 are typical of those which occur in gelatine film magnified ninety and ninety-five times respectively; in these instances transmitted light was used, as reflected light fails to reveal the narrow intersections between the filaments.

The colour of the filaments is always light brown when they are embedded in the film, and most of the collodion variety occur in this position: in the case of the gelatine papers, most of the crystallisation takes place upon the surface. With both types, the crystals assume a dead black color when they are upon the top of the film.

In Figures 249 and 450, nearly the whole of the action took place on the surface, as the images seen through the microscope were black excepting some portions at the edges which were within the film and consequently of a brown color; this difference will be noticed in the illustrations.

The chemical reduction probably happens when the emulsion dries, or soon afterwards, as the spots have been found in paper of comparatively fresh make; some paper has been kept for a long period to ascertain if the action occurs or increases with age, but neither feature was noticed.

The unending variety of the designs and their minute structure make them worthy of attention from all users of the microscope.

C. A. B.

ORNITHOLOGY.

By Wilfred Mark Webb, F.L.S.

ORNITHOLOGY AT THE BRITISH ASSOCIATION. —At the British Association meeting, held at Dundee, a considerable amount of interesting work on birds was recorded. In the final report of the Committee dealing with secondary sexual characters in birds presented to Section D (Zoölogy) among other matters the cause of sterility in hybrids was considered, and the following account was given: An attempt was made to rear hybrids between the common pheasant and the jungle fowl, but the incubation of about sixty eggs resulted in the hatching of a single chick, which died owing to a cerebral hernia two days after hatching. This chick on dissection proved to be a male, and the reproductive organs were in a perfectly normal condition for a chick of that age, showing no degenerative or retarded development. Three hybrid male pigeons (hybrid between domestic dove and pigeon) were obtained from a pigeon-fancier. These birds were kept for about a year and were paired with female pigeons successfully, and the eggs were incubated in the normal manner by both parents. In all cases the eggs were sterile. The three hybrids were killed and dissected, and their spermatozoa and testes, which on inspection appeared quite normal, were examined histologically. On comparison with normal doves and pigeons, it was found that the great majority of the spermatozoa of the hybrids were twice the normal size, and this abnormality of size was traced to the fact that the second maturation division was entirely suppressed. The abnormality was traced further back to the first maturation division, where it was found that the chromosomes, instead of forming the ordinary eight synaptic groups, were irregularly fragmented and scattered on the mitotic spindle, some of the chromative masses being much smaller, others much larger, than the normal synaptic chromosomes. Previous to this division it appeared that the spermatogonia in the testes were perfectly normal, so that we must ascribe the abnormality of the spermatozoa, and the consequent sterility of the hybrids, to the incapacity of the chromosomes derived from the two parents to form synaptic pairs. These results will shortly be published in detail in *The Quarterly Journal of Microscopical Science*.

Further observations on sterile hybrids are being made in the case of some birds presented by Mrs. Haig Thomas, which have been kept for varying times in aviaries and some of which are still alive. Investigation of the sterile male shows similar features to those observed in the case of the pigeon-dove hybrids, but other observations on sterile females and another male hybrid are not complete. The sterile female hybrids show a partial assumption of cock's plumage, and this is probably correlated with the atrophy of the ovary.

Another investigation was intended to discover if the inheritance of spurs in the domestic hen could be explained on the same lines as the inheritance of horns in horn-breeds of ewe; but the experiments have not been going on long enough to speak with any certainty.

Another experiment still in progress deals with the inheritance of an extra toe in the fowl.

Dr. C. J. Patton, who spent eight weeks at the Tuskar Light Station, County Wexford, summarised his remarks on bird migration as follows: In such a comprehensive study as the migration of birds as carried out personally, over a considerable period of time, at an isolated rock on which a lighthouse has been built, with a lantern of powerful illumination, so many problems present themselves for investigation, and so extensive and intricate are the statistics, that in order to cover the ground at my disposal I must here confine my remarks to some special features in connection with my subject which I hope will be of general interest. To the ornithologist of a country, and especially in the case of a small one like Ireland, where a complete knowledge of the avi-fauna is not so difficult to acquire, one of the most fascinating objects is to wait and watch for species which, either unknown or of very rare occurrence in their natural habitat, are attracted and decoyed by the luminous beams of the lantern under certain meteorological phases, when on passage. It is chiefly from the lighthouse that so many birds new to Ireland have been recorded, and during my visit I was enabled to add a few more to the list. Another feature of considerable interest in dealing with bird-migration presents itself at the Tuskar light-station, namely: to what extent certain supposed desultory or mere local migrants journey? Several knotty points can, I am of opinion, be disentangled as we study this subject at such an excellent observatory as the Tuskar Rock. For any land birds which appear, even when they alight and rest a few hours, are bent on making a passage. No land birds could reside here, where fresh water to drink is unavailable, food is very scarce (for some species absent altogether), and the rock is frequently wave-swept. The third and last feature I wish to refer to is in connection with the study of variation. Splendid opportunities present themselves, because such large numbers of certain species fall victims by striking the lantern that these can be collected and preserved with facility.

A very useful discussion arose as the result of a paper dealing with the food of birds, which was communicated by Professor J. Arthur Thomson. The details of the work are as follows:—The inquiry was begun in October, 1909, under the supervision of Professor Thomson, and with the valuable coöperation of Professor Trail. The investigator, Miss Laura Florence, M.A., B.Sc., has examined about one thousand eight hundred birds, chiefly from agricultural land in the N.E. of Scotland. It is too early to draw many definite conclusions, but the inquiry shows the need for examining large numbers from different areas, and throughout the year, if trustworthy information is to be forthcoming as to the injurious or beneficial activities of common birds. Many current opinions on this subject rest on far too narrow a basis.

Birds of ninety-five species have been examined, but large numbers of any one species have not been procurable except in a few cases, such as rooks and gulls. In some cases the verdict given by previous investigators, such as Professor Newstead, has been confirmed, e.g., as to the injuriousness of house-sparrow, wood-pigeon, and carrion-crow, and as to the beneficial activity of hedge-sparrow, field fare, lapwing, and plovers. On the other hand, there are several cases in which the results up to the present do not altogether confirm previous opinions; thus the diet of the black-headed gull and the common gull shows a striking resemblance to that of the useful lapwing. It is much to be desired that this inquiry, and others like it elsewhere, should be continued for a term of years; and the coöperation of farmers and others interested is solicited.

The usefulness of the investigations was emphasised by many speakers and an important point brought out was that if the waste grain eaten by birds after the harvest had been gathered in was not taken into consideration the balance might in many cases be in their favour. The need also for the making of investigations in many localities was brought forward; for a bird which is injurious in one locality may not be so in another.

Mr. Lansborough Thomson described his method of bird marking and gave some of the results, to which attention has already been called in "Knowledge"; his paper also was received with great cordiality and much commendation.

At the Conference of Delegates a short account illustrated by lantern slides was given by the Secretary of the Selborne Society on the successful experiment in Bird Protection made during the last eight or nine years in the Brent Valley Bird Sanctuary and the nesting boxes which have been designed in connection with it.

PHOTOGRAPHY.

By Edgar Senior.

PHOTO-MICROGRAPHY WITH HIGH POWERS.—In the last issue of "Knowledge," when dealing with medium power photo-micrography, we endeavoured to show that magnification beyond the degree necessary to observe distinctly all that it was possible for the objective to define, was practically useless, and that it was the aperture that determined the essential qualities required in the lens. We have an example before us which illustrates this admirably. Two objectives, one of which is a quarter of an inch having an aperture of ·95 N.A., the other a fiftieth of an inch, of ·98 N.A. Now, the former, according to theory, would be able to resolve lines or dots when so close together that ninety thousand two hundred and sixty were contained in the linear inch, and the magnifying power at ten inches would be forty diameters. With the latter the resolving power would be ninety-three thousand one hundred, and its magnifying power five hundred diameters at the same distance. The magnification is, therefore, out of all proportion to the resolving power, as without any eyepiece at all, the size of the image would be equal to, "and theoretically greater than," that obtained by means of the quarter-inch when used with a ten ocular. It, therefore, becomes difficult to understand what was gained by the use of an objective of this focus, leaving out of consideration the inconvenience

Figure 431. Bacilli, photographed with a *Zeiss* 2 mm. homogeneous immersion apochromatic objective N.A. 1·40 and a four projection ocular × 1900 diameters.

arising from its close working distance. However, as this latter objective has a larger aperture, there should be a gain in that respect. Realizing, then, the great value of aperture in microscopy, we see how essential it is that an objective should possess a wide one, when intended for use in the observation of minute objects such as bacilli, or the study of the

Figure 432.
The $\frac{1}{100}$ of a millimetre divisions of a stage micrometer × 1900 diameters.

structure in diatoms. Owing to the researches of Professor Abbe, in connection with the defining (resolving) power of the microscope, we have the general formulae 2λ N.A. as expressing it. That is, twice the wave length of light employed multiplied by the numerical aperture of objective. It should also be evident that anything which diminishes λ increases the resolving power of the lens, and as the wave length of light is less in a highly refracting medium than it is in air, we can understand the advantage gained by the use of homogeneous immersion objectives. The immersion fluid usually employed is cedar-wood oil, having a density of 1·515, and in order to thoroughly understand its use, we must consider the equation given by Professor Abbe, which determines the value of the numerical aperture; thus N.A. = n sin u, in which n stands for the density of the medium in which the front lens of the objective is immersed, and sin μ represents the sine of half the angular aperture. Suppose a dry objective having an angular aperture of 134° 9′ be the one considered, air being the medium in front of the lens, the index of refraction is unity, therefore n = 1. Half the angle of aperture is $\frac{134° 9'}{2} = 67° 45'$. Referring to a table of sines we find that the sine of 67° 45′ is ·92554, therefore the N.A. = 1 × 0·92554. Supposing that it were possible to use this same objective with cedar-wood oil between its front lens and the cover glass, then n would equal 1·515 and the N.A. = 1·515 × 0·92554 = 1·40. We thus see the great advantage of oil immersion, and how the N.A. determines the essential qualities of the objective with regard to its ability to resolve fine structure. Photography also places a still further power in our hands, as by its means and the employment of apochromatic objectives, we are able to make use of blue light, and so obtain greater resolution still, owing to their shorter wave length. That the use of high powers requires special care to be taken in the adjustment of the apparatus is generally well known; but more particularly is this the case in photo-micrography. In order to obtain successful results, the condenser and source of light must be carefully centred, so as to properly illuminate the object, and the auxiliary condenser employed in front of the lamp must be of such a focus that the image which it projects upon the sub stage condenser fills the entire aperture of the latter, when the principal condition for critical illumination is effected. It then only remains to focus the image of the lamp condenser into the object field by means of the rack and pinion with which the sub-stage is provided. The adjustments of the light having been made so as to suit the requirements of wide aperture immersion objectives, attention has to be directed to the objects themselves. In photographing diatoms the use of an apochromatic objective with a blue light filter is to be recommended, as the shorter wave lengths will act like an increased numerical aperture, and so augment the resolving power. In the case of bacteria, however, the conditions are quite different, as we are usually dealing with stained specimens, and the filter employed to obtain the necessary contrast must be in keeping with the absorption bands of the dye used in staining. If the attempt be made to increase contrast by reducing the aperture, there is great risk of destroying fine details, as well as the formation of very marked diffraction effects round the images themselves. It is therefore evident that a deal of care is required to obtain the best results. In taking the photograph of bacteria shown in Figure 431 a Zeiss two millimetre homogeneous immersion objective of N.A. 1·40 was employed, together with a four projection ocular. The source of light was a paraffin oil lamp, and an exposure of three minutes was given, using an Imperial orthochrome plate of 200 H. and D. The specimen being stained blue, a yellow screen was used to gain contrast. It may be further mentioned that as the three millimetre apochromat of Zeiss has the same N.A. (1·40) as the two millimetre, the former would, in many cases, be the best to use owing to its greater depth of focus.

DETERMINATION OF MAGNIFICATION.—Having taken the photograph it is often necessary to know the magnification of the image. This is easily found by removing the object and replacing it with a stage micrometer, "another name for a three by one slip upon which is cemented a cover glass ruled with lines separated by intervals of known value." If the distance between the images of two of these lines seen on the focusing screen be measured, the magnification is obtained by dividing the size of the image by that of the object. This is shown in Figure 432, which is a photograph of the lines on a stage micrometer one hundredth of a millimetre apart. The distance between the lines is practically nineteen millimetres, therefore $\frac{19}{1} \div \frac{1}{100} = 1,900$ diameters.

EXPOSURE TABLE FOR OCTOBER.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and the lens aperture F.16.

Day of the Month	Condition of the Light	Time of Day 10 a.m. and 2 p.m.	9 a.m. and 3 p.m.	8 a.m. & 4 p.m.
Oct. 1st	Bright	15 sec.	2 sec.	27 sec.
" "	Dull	3 "	4 "	54 "
Oct. 15th	Bright	18 sec.	25 sec.	4 sec.
" "	Dull	36 "	5 "	81 "
Oct. 30th	Bright	23 sec.	36 sec.	67 sec.
" "	Dull	46 "	70 "	1 30 "

Remarks.—If the subject be a general open landscape, take half the exposures given here.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

TWO-TOED HORSES. Professor K. Skoda, of the Veterinary College in Vienna, gives a precise account of two horses which had two toes well-developed on the fore-leg. Taking the first case, each fore-leg bore beside the ordinary single digit (No. III.) a second. This showed three joints, but did not reach the ground. There was a metacarpal (or palm-bone) for this second digit, largely fused with the ordinary third metacarpal. Besides this there was the usual free splint or fourth metacarpal, and there seemed to be actually a rudimentary first metacarpal! Especially when one looks into the details of the case does it look like a reversion to a remote ancestral type with polydactylous feet.

EDIBLE SEA SQUIRTS.—It cannot be said that the natives of these islands compare well with others in the experimental study of the edible. We shrink from much that is wholesome and refuse some of our best fishes until they are filleted and re-named. We lag far behind the Japanese, for instance, in gustatory inquisitiveness, for they have learned to make an entree of jellyfish and to make a toothsome delicacy of two species of sea squirt (*Tethyum*). Mr. A. G. Huntsman points out that very similar forms are readily available on the coasts of Canada, and he encourages experiment by precedent. "The inhabitants of Peru and Chili use as food two species of *Pyura* that occur on their coasts, and species of the genus *Microcosmus* are exposed for sale in the markets of Southern Europe." There is nothing in a name, of course, but a dish of *Microcosmus* should meet the wants of a diversity of palates. Most sea-squirts have but little muscle, and that unstriped; but in the Styelids and Tethyids the musculature is often quite thick.

NATURAL HISTORY OF SLIPPER-LIMPET.—The American limpet, or slipper-limpet, known technically as *Crepidula fornicata*, was introduced into England about 1880, and has spread rapidly on oyster grounds. Mr. Orton, who has recently studied its natural history, says that there is no doubt that it has been introduced along with American oysters, on which it fixes itself, and that the introduction is probably going on. There are many interesting features in this addition to the British fauna. It takes special care of its spawn. "It constructs about fifty to sixty membranous bags, into each of which it passes about two hundred and fifty eggs, and as the bags are made and filled with eggs they are closed and fastened together by short cords. These cords are finally all stuck on to the surface on which the slipper-limpet happens to be sitting, so that when by taking away the spawning individual the spawn is uncovered, it looks like a bundle of balloons, each containing a number of eggs." Another feature is their curious habit of sticking together in long chains, by one individual sitting on the back of another. There may be thirteen in a chain, and the bottom individuals are females, the end individuals males, and those between these are intermediate sex forms between male and female. The fact is, as Orton has shown, that the slipper-limpet is a "protandrous hermaphrodite," *i.e.*, it is first a male and then a female. The eggs develop into free-swimming larvae, which may be scattered far and wide. As the slipper-limpets feed on the same food (diatoms and the like) they compete with oysters; but it remains to be seen whether there is not plenty of food for both parties.

THE MERMIS FAMILY.—The Mermithidae form an interesting family of threadworms, not unfamiliar to those who are fond of gardening. The mature adults are found in the earth or in fresh water, and so are the first larval stages. The second larval forms are parasitic in Tracheata and Gastropods. In the earth the adults are sometimes found rolled up in a spiral or coil, sometimes male and female together. The males are smaller, thinner, more mobile, and with better developed sense-organs at the head-end. Sometimes the eggs are laid just where the female was living; in other cases, when the ground is very damp, an interesting migration occurs which many observers have noticed. The females creep up plants, *e.g.*, cabbages, probably seeking out a drier place for egg-laying. The young larvae leave the ground and bore actively into beetles, caterpillars, millipedes, slugs, and so on. It is noteworthy that no food is taken either by the adults or by the young larvae. All the feeding is done by the second larval forms during the parasitic period. Another interesting feature is that the Mermithidae differ from most other Nematodes in being able to survive mutilation and in showing some measure of regenerative capacity. There have been two recent revisions of the family, one by E. von Daday (*Revue Suisse Zool.* XIX), and another by A. Hagmeier (*Zool. Jahrbucher* XXXII).

TOOTH-WORMS. In some parts of Hungary there is a vulgar belief that bad toothache is due to minute worms. By their writhing and gnawing they produce abscesses in the gum, and one of the popular cures is to fumigate the mouth very thoroughly so that the worms are driven out from their hiding-places. The thorough fumigation of the mouth is a wide-spread habit all over the world, but the tooth-worm myth is rare. It may have had an origin, one might suppose, in the very rare occurrence of fly-larvae (*Sarcophaga wohlfahrti*) in bad buccal abscesses, but Professor Karol Sajo's examination of the alleged "tooth-worms" which the Hungarian sufferers are willing to demonstrate on the spot, has shown that they are the funicles of the seeds of *Hyoscyamus*, which are used, we suppose, as an anodyne.

FRESHWATER STING-RAYS OF THE GANGES.—It has been known since the beginning of the nineteenth century that rays occur high up the Ganges, but considerable doubt has existed as to the species. This has been cleared up by B. L. Chaudhuri, who shows that there are at least two freshwater Batoids in the Ganges, viz., *Trygon fluviatilis* and *Hypolophus sephen*. These species are not only found one thousand miles above tidal influence, but also breed freely in fresh water.

FISHES AND MALARIA.—In 1905, it was pointed out that the Barbadoes were remarkably free from malaria, and the reason suggested for this was that the mosquito larvae (which elsewhere grow up into distributors of the malaria organism) were devoured by a small fish, popularly known as "millions," very abundant in all the streams and pools. Captain R. B. Seymour Sewell and B. L. Chaudhuri have recently shown that there are numerous (they describe eleven species) Indian fishes which are of proved utility as mosquito-destroyers. Thus we have another thread in the web of life—"fishes may be a very important agent in regulating and diminishing the degree of malarial infection in any given district."

ERI SILK.—Messrs. H. Maxwell Lefroy and C. C. Ghosh give an account of Eri silk, which is grown in Assam for local use, and may perhaps have a big future before it. Eri silk cannot be reeled, for the cocoon is in layers, not in a continuous thread. The moth (*Attacus ricini*) can push its way out without softening or cutting the fibres, and may be allowed to mature within the cocoon and emerge. The fibre can be spun as cotton is, and the yarn can be woven quite readily. The resulting silk cloth ("Endi") is the most durable cloth known in India, and takes dye well. The silkworms live on Castor leaves.

PEARLS AND PARASITES.—After a searching inquiry, H. Lyster Jameson comes to the conclusion that there is insufficient evidence for the theory that the pearls of the Ceylon Pearl Oyster are due to the larvae of the tapeworm *Tetrarhynchus unionifactor*. It appears probable that the simultaneous presence of pearls and tapeworms in the Ceylon Pearl Oyster is a case of two parallel diseases, comparable to the case of a dog infected simultaneously with tapeworms and mange. According to Jameson, pearls arise round nuclei of some variety of shell-substance formed when the normal rhythm of secretion is disturbed.

SOLAR DISTURBANCES DURING AUGUST, 1912.

By FRANK C. DENNETT.

AUGUST was remarkable for its lack of clear sky, but during the month only two days were entirely missed, the 15th and the 23rd. Spots were only seen on four days, the 11th, 12th, 21st and 28th, and on ten others only faculae were visible, leaving fifteen upon which the disc appeared quite free from disturbance. At noon on August the 1st the longitude of the central meridian was 224° 42′.

No. 12.—A minute group of pores only seen on the evening of the 11th and on the morning of the 12th, the true position having to be estimated rather than measured.

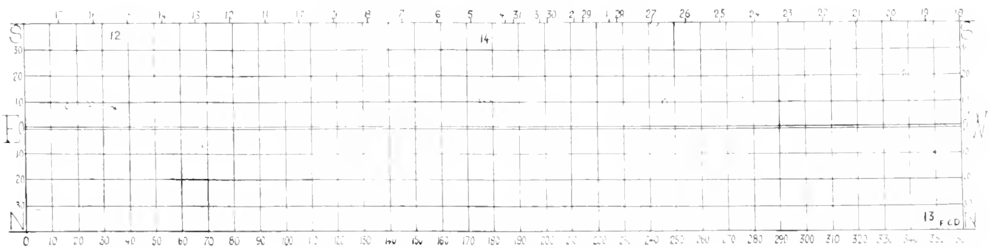
No. 13.—A penumbraless pore, bright edged, with its eastern edge somewhat rough, and on its western side the surface showed traces of minute black specks, but it only lasted one day, the 21st.

No. 14.—A group of minute pores observed with difficulty on the 28th in the place seen on the previous day to be occupied by a faculic area. The position has been given by estimation, as measures were impossible. It appears to have been situated directly south of the place in which No. 11 had been seen in July.

Faculic areas were observed on August 2nd and 3rd about longitude 242°, and south latitude 40°. On the 7th, near the western limb. On the 10th and 11th east toward south-east, in longitudes 16° and 34° and latitudes 9° and 4° to 8° south respectively. On the 19th, within the eastern limb a little south, in longitude 276° and latitude 12°. On the 21st a faculic ridge from 9° to 11° south, near the western limb, longitude 25°; also a knot at 247°, 10° south, and another in very high southern latitudes near the central meridian. On the 25th a double knot of faculae was approaching the south-western limb, situated longitude 339°, and south latitude 19° to 22°. And on the 27th, some 30° within the eastern limb, longitude 179°, south latitude 10°, the faculic disturbance was seen which heralded the group No. 14.

Our chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, C. Frooms, and the writer.

DAY OF AUGUST, 1912.



SIR JOSEPH DALTON HOOKER,

O.M., G.C.S.I., C.B., M.D., F.R.S. (1817-1911).

By F. O. BOWER, Sc.D., F.R.S.,

Regius Professor of Botany in the University of Glasgow.

(Being the Chairman's Address to the Conference of Delegates at the Dundee Meeting of the British Association for the Advancement of Science, 1912.)

I have thought that in addressing this conference of delegates, I could not do better than take as my subject Sir Joseph Dalton Hooker, whose death in December, 1911, has closed a strenuous life of ninety-four years. The life we now commemorate was one of action throughout. Naturally with age the bodily strength waned. But Sir Joseph Hooker's vivid mind remained unimpaired to the end. He even continued his detailed observations till very shortly before his death in December last. The list of his published works extends from 1837 to 1911, a record hardly to be equalled in any walk of intellectual life.

I do not propose to give any consecutive biographical sketch of this great man. Several such have already appeared. I think I shall better engage your interest by indicating the various lines of activity in which he excelled. He was never a professional teacher, except for a short period of service as assistant in Edinburgh. There was a moment when he might have been Professor in Edinburgh, but it passed. He left no pupils, except in the sense that all botanists have learned from him through his books. We shall contemplate him rather as a traveller and geographer, as a geologist, as a morphologist, as an administrator, as a scientific systematist, and above all as a philosophical biologist. He was all of these, and almost any of these heads might have sufficed for a complete address. I will endeavour, however imperfectly, to touch upon them all.

The experiences of Hooker as a *traveller* began immediately after taking his degree, with his commission in 1839 as assistant surgeon and botanist in the "Erebus." Scientific Exploration was still in its heroic age. Darwin was only three years back from the voyage of the "Beagle." We may well hold the years from 1831, when the "Beagle" sailed, to 1851, when Hooker returned from his Indian journey, or 1852, when Wallace returned from the Amazon, to have been its golden period. Certainly it was if we measure by results. Unmatched opportunity for travel in remote and unknown lands was then combined with unmatched capacity of those who engaged in it. Nor was this a mere matter of chance. For Darwin, Wallace, and Hooker all seized, if they did not in some measure make, their opportunity.

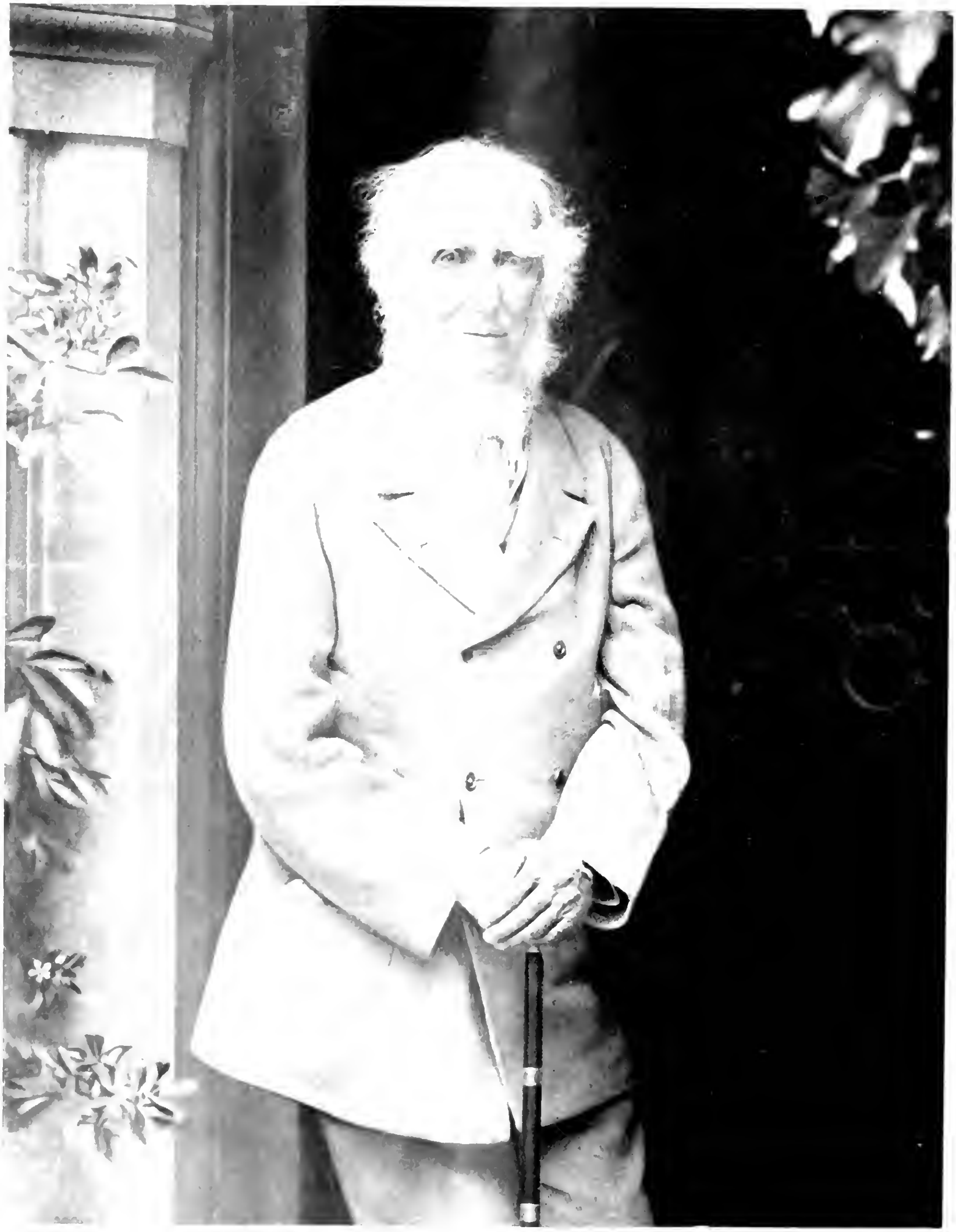
The intrepid Ross, with his two sailing ships, the "Erebus" and the "Terror," probed at suitable seasons during four years the extreme south. The very names of the Great Ice Barrier, M'Murdo Sound, Mount Erebus and Mount Terror, made familiar to us by adventures seventy years later under steam, remain to mark some of his additions to the map of the world. Young Hooker took his full share of risks, up to the point of being peremptorily ordered back on one occasion by his commanding officer. To his activity and willingness, combined with an opportunity that can never recur in the same form, is due that great collection of specimens, and that wide body of fact which he acquired. On the outward and return voyages, or in the intervals when the season was not favourable for entering the extreme southern seas, the expedition visited Ascension, St. Helena, the Cape, New Zealand, Australia, Tasmania, Kerguelen Island, Tierra del Fuego, and the Falkland Islands. The prime object of the voyage was a magnetic survey, and this determined its course. But it brought this secondary consequence; that Hooker had the chance of observing and collecting upon all the great circumpolar areas of the southern hemisphere. The results he later welded together into his first great work, "The Antarctic Flora."

Very soon after his return from the Antarctic the craving for travel broke out afresh in him. He longed to see a tropical Flora in a mountainous country, and to compare it at different levels with that of temperate and arctic zones. Two alternatives arose before him: the Andes and the Himalaya. He chose the latter, being influenced by promises of assistance from Dr. Falconer, the Superintendent of the Calcutta Garden. But before he left England his journey came under the recognition of Government. He not only received grants on the condition that the collections made should be located in the Herbarium at Kew, but he was accredited by the Indian Government to the Rulers, and the British Residents, in the countries whose hitherto untrodden ways he was to explore. After passing the cold season of 1848 in making himself acquainted with the vegetation of the plains and hills of Western Bengal, he struck north to the Sikkim Himalaya. Hither he had been directed by Lord Auckland and by Dr. Falconer, as to ground unbroken by traveller or naturalist. The story of this remarkable journey, its results and its vicissitudes, including the forcible detention of himself and his companion, Dr. Campbell, by a faction of the Court of Sikkim, is to be found in his "Himalayan Journal." This most fascinating volume of travel was published in 1854. It tells how he spent two years in the botanical exploration and topographical survey of the state of Sikkim, and of a number of the passes leading into Thibet; and how towards the close of 1848 he even crossed the western frontier of Sikkim, and explored a portion of Nepal that has never since been open to travellers. In 1849 he returned to Darjeeling, and busied himself with arranging his vast collections. Here he was joined by an old fellow-student of Glasgow, Dr. Thomas Thomson, son of the professor of that name. The two friends spent the year 1850 in the botanical investigation of Eastern Bengal, Chittagong, Silhet, and the Khasia hills. In 1851 they returned together to England.

The botanical results of these Indian journeys were immense, and they provided the material for much of Hooker's later scientific writing. Nearly seven thousand species of Indian plants were collected by these two Glasgow graduates. But Hooker was not a mere specialist. His Journal is full of other observations, ethnographical, ornithological and entomological. His topographical results especially were of the highest importance. They formed the basis of a map published by the Indian Topographical Survey. By the aid of it the operations of various campaigns and political missions have since been carried to a successful issue. If he were not known as a botanist, he would still have his assured place as a geographer.

After his return from India, nine years ensued of quiet work at home. But in 1860 Hooker took part in a scientific visit to Syria and Palestine, ascending Mount Lebanon, where he specially paid attention to the decadent condition of the Cedars, his observations leading later to a general discussion of the genus. Again a period of ten years intervened, his next objective being Morocco. In 1871, with Mr. Ball and Mr. Maw, he penetrated the Atlas Range, never before examined botanically. His last great journey was in 1877, when he was sixty years of age. With his old friend, Prof. Asa Gray, of Harvard, he visited Colorado, Wyoming, Utah, the Rocky Mountains, the Sierra Nevada, and California. Prof. Coulter, of Chicago, who was one of the party in the Rockies, has told me how difficult it was to round up the two elderly enthusiasts to camp at night.

This is an extraordinary record of travel, especially so when we remember that all the journeys were fitted into the intervals



Sir [illegible] C.B., M.D., F.R.S.

of an otherwise busy life of scientific work and administration. At one time or another he had touched upon every great continental area of the earth's surface. Many isolated islands had also been examined by him, especially on the Antarctic voyage. Not only were fresh regions thus opened up for survey and collection, but each objective of the later journeys was definitely chosen for scientific reasons. Each expedition helped to suggest or to solve major problems. Such problems related not only to the distribution, but also to the very origin of species. Darwin saw this with unerring judgment as early as 1845. Hooker was then but twenty-eight years old, and the records of the Antarctic voyage were only in preparation. Nevertheless, Darwin wrote with full assurance in a letter to Hooker himself: "I know I shall live to see you the first authority in Europe on that grand subject, that almost keystone of the laws of Creation, Geographical Distribution." Never was a forecast more fully justified. But that position, which Hooker undoubtedly had, could only have been attained through his personal experience as a traveller. Observation at first hand was the foundation upon which he chiefly worked. Hooker the traveller prepared the way for Hooker the philosopher.

Sir Joseph Hooker would probably have declined to consider himself as a *geologist.* He was, however, for some eighteen months official botanist to the Geological Survey of Great Britain. He was appointed in April, 1846, but relinquished the post in November, 1847, in order to start on his Himalayan journey. During that short period three memoirs were published by him on plants of the Coal Period. They embodied results derived from the microscopic examination of plant-tissues preserved in Coal Balls, a study then newly introduced by Witham, and advanced by Mr. Binney. It has since been greatly developed in this country. Such studies were continued by him at intervals up to 1855. While he was thus among the first to engage in this branch of enquiry, he may be said to have originated another line of study, since largely pursued by geologists. For he examined samples of diatomaceous ooze from the ocean-floor of the Antarctic, and so initiated the systematic treatment of the organic deposits of the deep sea. Yet another branch of geological enquiry was advanced by him in the Himalaya. For there he made observations on the glaciers of that great mountain chain, his notes supplying valuable material to both Lyell and Darwin. He also accumulated valuable data concerning the stupendous effects of sub-aërial denudation at great elevations. His latest contribution of a geological character was in 1889, when he returned to an old problem of his youth, the Silurian fossil, *Pachytheca.* But he had to leave the question of its nature still unsolved. This geological record is not an extensive one. But the quality and rapidity of the work showed that it was the time and opportunity and not the faculties that were wanting. Moreover, it is worthy of remark that the problems he handled were all nascent at the time he worked upon them.

The list of Sir Joseph Hooker's memoirs which deal *morphologically* with more limited subjects than is possible in floristic works, is a restricted one. In 1856 he produced a monograph on the Balanophoraceae, based upon collections of material from the most varied sources. It is still an authority very widely quoted on these strange parasites. In 1859 he described the development and structure of the Pitchers of *Nepenthes,* while the physiological significance of these and other organs of carnivorous plants, formed the subject of an Address before the British Association at Belfast, in 1874. And in 1863 his great monograph appeared upon that most remarkable of all Gymnospermic plants, *Welwitschia.* These works bore the character of a later period than the time when they were produced. In Britain, between 1840 and 1875, investigation in the laboratory, by microscopic analysis of tissues, was almost throttled by the overwhelming success of systematic and descriptive work. The revival of investigation in the laboratory rather than that in the herbarium dates from about 1875. But we see that Hooker was one of the few who, prior to that revival, pursued careful microscopic analysis side by side with systematic and floristic work.

The noble establishment of the Royal Gardens at Kew is often spoken of as the Mecca of botanists. It is also the Paradise of the populace of London. It was the Hookers, father and son, who made Kew what it is. When we contemplate Sir Joseph as an *administrator,* we immediately think of the great establishment which he and his father ruled during the first half century of its history as a public institution. Kew had existed for long as a Royal appanage before it was handed over to the nation. The Botanic Garden had, indeed, ranked for upwards of half a century as the richest in the world. But after the death of King George III it had retrograded scientifically. On the accession of Queen Victoria a revision of the Royal Household had become necessary. It was then decided to transfer the garden to the Commissioners of Woods and Forests. This took place in 1840, and in 1841 Sir William Hooker, who was then Professor in Glasgow, was appointed the first Director. The move to Kew, whither he took his private library, herbarium, and museum, was carried out in the absence of his son, who was still in the Antarctic. It was not till the Himalayan journey was over in 1851 that Sir Joseph settled at Kew, his great collections having already been consigned there by agreement with the Government. In 1855 he was appointed assistant to his father in the Directorship. Finally, he became himself Director on his father's death in 1865, and he held the position for twenty years.

So long associated together, it is difficult to disentangle the parts that father and son actually played in the creation of Kew as it now is. Nor is there need to attempt it. The original area of the Garden at Kew was less than twenty acres. But in 1855, when Sir Joseph joined his father in the directorate, it had grown by successive additions to seventy acres. Finally, the large area of six hundred and fifty acres came under the Director's control. Numerous large glass houses were built. Three museums were established, and the vast Herbarium and Library founded and developed. The Garden Staff rose to more than one hundred men. The day-by-day administration of such an establishment would necessarily make great demands upon the time, energy, tact, and skill of its official head. But in addition there was the growing correspondence to be attended to, on the one hand with botanists all over the world, on the other with the Government Departments, and especially with the Indian and Colonial Offices. As the activity of the Garden extended, there grew up a large staff of scientific experts and artists, whose duties centred round the Herbarium and Library. These all looked to the Director for their guidance and control. The descriptive work prepared by them for publication took formidable dimensions. The production of the floras of India, and of the Colonies, the publication of which was conducted under Government subvention, had to be organised and carried through. These matters are mentioned here to give you some idea of the extent and complexity of the work which was being carried on at Kew. For ten years as Assistant Director, and for twenty years as Director, Sir Joseph Hooker guided this complex machine. The efficiency of his rule was shown by the increasing estimation in which the Garden was held by all who were able to judge.

It was the founding of the Herbarium and Library at Kew which, more than anything else, strengthened the scientific establishment. As taken over from the Crown the Garden possessed neither. But Sir William brought with him from Glasgow his own collections, already the most extensive in private hands. For long years after coming to Kew he maintained and added to his store at his own expense. But finally his collections were acquired after his death by Government. His herbarium was merged with the fine herbarium of Bentham, already presented to the nation in 1857. Thus, the opening years of Sir Joseph's directorate saw the organisation upon a public basis of that magnificent Herbarium and Library, which now contains not only his father's collections, but also his own. Among the enormous additions since made to the Herbarium of Kew, its greatest interest will always be centred in the Hookerian collections which it contains.

It might be thought that such drafts as these upon the time and energies of a scientific man would leave no opportunity for other duties. But it was while burdened with the directorship that Sir Joseph was called to the highest administrative office in science in Great Britain. He served as President of the Royal Society from 1873 to 1878. The obligations of that position are far from being limited to the requirement of the Society itself. The Government of the day has always been in the habit of taking its president and officials into consultation in scientific matters of public importance. In these years the administrative demands upon Sir Joseph were the greatest of his life. They are marked by a temporary pause in the stream of publication. None of his own larger works belong to this period. It happens only too often in this country that our ablest men are thus paralysed in their scientific careers by the potent vortex of administration. Not a few succumb, and cease altogether to produce. They are caught as in the eddy of the Lorelei, and are so hopelessly entangled that they never emerge again. They fail to realise, or realise too late, that the administration of matters relating to a science is not an end in itself, but only a means to an end. Some, the steadfast and invincible seekers after truth, though held by the eddy for a time, pass again into the main stream. Hooker was one of these. The Presidency of the Royal Society ended at the usual term of five years. Seven years later he demitted office as Director of Kew, under the Civil Service rule. He was thus free in 1885, still a young man in vigour though not in years. For over a quarter of a century after retirement he devoted the energy of his old age to peculiarly fruitful scientific work. Thus the administrative tie upon him was only temporary. So long as it lasted he faithfully obeyed the call of duty, notwithstanding the restrictions it imposed.

I shall not attempt to give an exhaustive catalogue of the works upon which the reputation of Sir Joseph Hooker as a *scientific systematist* was founded. Were I to do so our time would be gone before the list was completed. It must suffice briefly to consider his four greatest systematic works, "The Antarctic Flora," "The Flora of British India," "The Genera Plantarum," and the "Kew Index."

We have seen how on the Antarctic voyage Hooker had the opportunity of collecting on all the great circumpolar areas of the Southern Hemisphere. His "Antarctic Flora" was based on the collections and observations then made. It was published in six large quarto volumes. All the known facts that could be gathered were incorporated, so that they became systematically elaborated and complete floras of the several countries. Moreover, in the last of them, the "Flora Tasmaniae," there is an Introductory Essay, which in itself would have made Hooker famous. We shall return to this later. Meanwhile we recognise that the publication of the "Botanical Results of Ross's Voyage" established Hooker's reputation as a traveller and botanist of the first rank.

What he did for the Antarctic in his youth he continued in mature life for British India. While the publication of the "Antarctic Flora" was still in progress, he made his Indian journeys. The vast collections amassed by himself and Dr. Thomson were consigned by agreement with Government to Kew. Thither had also been brought in 1858 "seven waggon-loads of collections from the cellars of the India House in Leadenhall Street, where they had been accumulating for many years." They included the herbaria of Falconer and Griffith. Such materials, with other large additions made from time to time, flowed into the already rich Herbarium at Kew. This was the material upon which Sir Joseph Hooker was to base his *Magnum Opus*, the "Flora of British India."

Already in 1855 Sir Joseph, with his Glasgow college friend, Thomas Thomson, had essayed to prepare a "Flora Indica." It never advanced beyond its first volume. But if it had been completed on the scale set by that volume, it would have reached nearly twelve thousand pages! After a pause of over fifteen years Hooker made a fresh start, aided now by a staff of collaborators, and the "Flora of British India" was the result. It was conceived, he says with regret, upon a restricted plan. Nevertheless it ran to seven volumes, published between the years 1872 and 1897. There are nearly six thousand pages of letterpress, relating to sixteen thousand species. It is, he says in the Preface, a pioneer work, and necessarily incomplete. But he hopes it may "help the phytographer to discuss problems of distribution of plants from the point of view of what is perhaps the richest, and is certainly the most varied botanical area on the surface of the globe."

Scarcely was this great work ended when Dr. Trimen died. He left the "Ceylon Flora," on which he had been engaged, incomplete. Three volumes were already published, but the fourth was far from finished, and the fifth hardly touched. The Ceylon Government applied to Hooker, and though he was now eighty years of age, he responded to the call. The completing volumes were issued in 1898 and 1900. This was no mere raking over afresh the materials worked already into the "Indian Flora." For Ceylon includes a strong Malayan element in its vegetation. It has, moreover, a very large number of endemic species, and even genera. This last floristic work of Sir Joseph may be held fitly to round off his treatment of the Indian Peninsula. His last contribution to its botany was in the form of a "Sketch of the Vegetation of the Indian Empire," including Ceylon, Burma, and the Malay Peninsula. It was written for the "Imperial Gazetteer," at the request of the Government of India. No one could have been so well qualified for this as the veteran who had spent more than half a century in preparation for it. It was published in 1904, and forms the natural close to the most remarkable study of a vast and varied flora that has ever been carried through by one ruling mind.

The third of the systematic works selected for our consideration is the "Genera Plantarum." It was produced in collaboration with Mr. Bentham. Of its three massive volumes the first was published in 1865, and the work was completed in 1883. It consists of a codification of the Latin diagnoses of all the genera of flowering plants. It is essentially a work for the technical botanist, but for him it is indispensable. Of the known species of plants many show such close similarity of their characters that their kinship is recognised by grouping them into genera. In order that these genera may be accurately defined it is necessary to have a *précis* of the characters which their species have in common. This must be so drawn that it shall also serve for purposes of diagnosis from allied genera. Such drafting requires not only a keen appreciation of fact, but also the verbal clearness and accuracy of the conveyancing barrister. The facts could only be obtained by access to a reliable and rich herbarium. Bentham and Hooker, working together at Kew, satisfied these drastic requirements more fully than any botanists of their time. The only real predecessors of this monumental work were the *Genera Plantarum* of Linnaeus (1707-1764) and of Jussieu (1789), to which may be added that of Endlicher (1836-1840). But all of these were written while the number of known genera and species was smaller. The difficulty of the task of Bentham and Hooker was greatly enhanced by their wider knowledge. But their *Genera Plantarum* is on that account a nearer approach to finality. Hitherto its supremacy has not been challenged.

The fourth of the great systematic works of Hooker mentioned above was the *Index Kewensis.* It was produced upon the plan and under the supervision of Sir Joseph by Mr. Daydon Jackson and a staff of clerks. The publication began in 1893, and successive supplements to its four quarto volumes are still appearing at intervals. The expense was borne by Charles Darwin. The scheme originated in the difficulty he had found in the accurate naming of plants. For "synonyms" have frequently been given by different writers to the same species, and this had led to endless confusion. The object of the Index was to provide an authoritative list of all the names that have been used, with reference to the author of each and to its place of publication. The habitat of the plant was also to be given. The correct name in use according to certain well-recognised rules of nomenclature was to be indicated by type different from that of the synonyms superseded by it. The only predecessor of such an Index was Steudel's *Nomenclator Botanicus*, a book greatly prized by Darwin, though long out of date. He wished at first to produce a modern edition of Steudel's *Nomenclator.* This idea was, however, amended, and it was resolved to construct a new list of genera and species, founded upon Bentham and Hooker's *Genera Plantarum*. Sir Joseph Hooker was asked by Mr. Darwin to take into consideration the extent and scope of the proposed work, and to suggest the best means of having it executed. He undertook the task, and it was he who laid out the lines to be followed. After years of labour by Mr. Daydon Jackson and his staff, the work was produced. But Sir Joseph read and narrowly criticised all the proofs. Imagine four large quarto volumes, containing in the aggregate two thousand five hundred pages, each page bearing three columns of close print, and each column about fifty names. The total figures out to about three hundred and seventy-five thousand specific names, all of which were critically considered by the octogenarian editor! Surely no greater technical benefit was ever conferred upon a future generation by the veterans of science than this Index. It smooths the way for every systematist who comes after. It stands as a monument to an intimate friendship. It bears witness to the munificence of Darwin, and the ungrudging personal care of Hooker.

But the author of great works such as these was still willing to help those of less ambitious flights. I must not omit to mention two books which, being more modest in their scope, have reached the hands of many in this country. In 1870 Hooker produced his "Student's Flora of the British Islands," of which later editions appeared in 1878 and 1884. It was published in order to "supply students and field botanists with a fuller account of the plants of the British Isles than the manuals hitherto in use aim at giving." In 1887 he edited, after the death of its author, the fifth edition of Bentham's "Handbook of the British Flora." Both of these still hold the field, though they require to be brought up to date in point of classification and nomenclature.

I hope I have not wearied you with these brief sketches of four of the great systematic works of Sir Joseph Hooker. I have gone somewhat more into detail than is quite justified in a public speech. But this has been done with a definite end in view. It was to show you how fully he was imbued with the old systematic methods; how he advanced, improved and extended them, and was in his time their chief exponent. His father had held a similar position in the generation before him. But the elder Hooker, true to his generation, treated his species as fixed and immutable. He did not generalise from them. His end was attained by their accurate recognition, delineation, description, and classification. The younger Hooker, while in this work he was not a whit behind the best of his predecessors, saw further than they. He was not satisfied with the mere record of species as they were. He sought to penetrate the mystery of the origin of species. In fact, he was not merely a scientific systematist in the older sense. He was a ***philosophical biologist*** in the new and nascent sense of the middle period of the nineteenth century. He was an almost life-long friend of Charles Darwin. He was the first confidant of his species theory, and, excepting Wallace, its first whole-hearted adherent. But he was also Darwin's constant and welcome adviser and critic. Well indeed was it for the successful launch of evolutionary theory that old-fashioned systematists took it in hand. Both Darwin and Hooker had wide and detailed knowledge of species as the starting-point of their induction.

Before we trace the part which Hooker himself played in the drama of evolutionary theory, it will be well to glance at his personal relations with Darwin himself. He had read the proof-sheets of the "Voyage of the 'Beagle'" while still in his last year of medical study. But before he started for the Antarctic he was introduced to its author. It was in Trafalgar Square, and the interview was brief but cordial. On returning from the Antarctic, correspondence was opened in 1843. In January, 1844, Hooker received the memorable letter confiding to him the germ of the Theory of Descent. Darwin wrote thus: "At last gleams of light have come, and I am almost convinced that species are not (it is like confessing a murder) immutable:—I think I have found (here's presumption!) the simple way by which species become exquisitely adapted to various ends." This was probably the first communication by Darwin of his species-theory to any scientific colleague.

The correspondence thus happily initiated between Darwin and Hooker is preserved in the "Life and Letters of Charles Darwin," and in the two volumes of "Letters" subsequently published. They show on the one hand the rapid growth of a deep friendship between these two potent minds, which ended only beside the grave of Darwin in Westminster Abbey. But what is more important is that these letters reveal, in a way that none of the published work of either could have done, the steps in the growth of the great generalisation. We read of the doubts of one or the other; the gradual accumulation of material facts; the criticisms and amendments in face of new evidence; and the slow progress from tentative hypothesis to assured belief. We ourselves have grown up since the clash of opinion for and against the mutability of species died down. It is hard for us to understand the strength of the feelings aroused: the bitterness of the attack by the opponents of the theory, and the fortitude demanded from its adherents. It is best to obtain evidence on such matters at first hand; and this is what is supplied by the correspondence between Darwin and Hooker.

How complete the understanding between the friends soon became is shown by the provisions made by Darwin for the publication of his manuscripts in case of sudden death. He wrote in August, 1854, the definite direction "Hooker by far the best man to edit my species volume": and this notwithstanding that he writes to him as a "stern and awful judge and sceptic." But again, in a letter a few months later, he says to him: "I forgot at the moment that you are the one living soul from whom I have constantly received sympathy." I have already said that Hooker was not only Darwin's first confidant but also the first to accept his theory of mutability of species. But even he did not fully assent to it till after its first publication. The latter point comes out clearly from the letters. In January, 1859, six months after the reading of their joint communications to the Linnaean Society, Darwin writes to Wallace: "You ask about Lyell's frame of mind. I think he is somewhat staggered, but does not give in . . . I think he will end by being perverted. Dr. Hooker has become almost as heterodox as you or I, and I look at Hooker as by far the most capable judge in Europe." In September 1859 Darwin writes to W. D. Fox: "Lyell has read about half of the volume in clean sheets . . . He is wavering so much about the immutability of species that I expect he will come round. Hooker has come round, and will publish his belief soon." In the following month, writing to Hooker, Darwin says: "I have spoken of you here as a convert made by me; but I know well how much larger the share has been of your own self-thought." A letter to Wallace of November, 1859, bears this postscript: "I think that I told you before that Hooker is a complete convert. If I can convert Huxley I shall be content." And lastly, in a letter to W. B. Carpenter, of the same month, Darwin says: "As yet I know only one believer, but I look at him as of the greatest authority, viz., Hooker." These quotations clearly show that, while Lyell wavered, and Huxley had not yet come in, Hooker was a complete adherent in 1859 to the doctrine of the mutability of species. Excepting Wallace, he was the first, in fact, of the great group that stood round Darwin, as he was the last of them to survive.

The story of the joint communication of Darwin and of Wallace to the Linnaean Society "On the tendency of Species to form Varieties, and on the Perpetuation of Varieties and Species by Natural Means of Selection" will be fresh in the minds of you all, for the fiftieth anniversary of the event was lately celebrated in London. It was Sir Charles Lyell and Sir Joseph Hooker who jointly, and with the authors' permission, communicated the two papers to the society, together with the evidence of the priority of Darwin in the enquiry. Nothing could then have been more apposite than the personal history which Sir Joseph gave at the Darwin-Wallace celebration, held by the Linnaean Society in 1908. He then told, at first hand, the exact circumstances under which the joint papers were produced. Nor could the expressions used by the President when thanking

Sir Joseph, and presenting to [illegible] Darwin Wallace Medal, have been improved. He said: "The incalculable benefit that your constant friendship, advice, and alliance were to Mr. Darwin himself, is summed up in his own words, used in 1864: 'You have represented for many years the whole great public to me.'" The President then added: "Of all men living it is to you more than to any other that the great generalisation of Darwin and Wallace owes its triumph."

The very last appearance of Hooker at any large public gathering of biologists was at the centenary of Darwin's birth, celebrated at Cambridge, in 1909. None who were there will forget the tall figure of the veteran, aged, but still vigorous, with vivacity in every feature. How gladly he accepted the congratulations of his many friends, and how heartily he rejoiced over the full acceptance of the theory he had himself done so much to promote. The end came only two years later, in December last. Many will have wished that the great group of the protagonists of Evolution, Darwin, Lyell, and Hooker, should have found their final resting-place together in Westminster Abbey. But this was not to be. Personal and family ties held him closer to Kew. And he lies there in classic ground beside his father.

Having thus sketched the intimate relations which subsisted between Hooker and Darwin, it remains to appraise his own positive contributions to Philosophical Biology. He himself, in his Address as President of the British Association at Norwich in 1868, gives an insight into his early attitude in the enquiry into biological questions. "Having myself," he says, "been a student of Moral Philosophy in a Northern University, I entered on my scientific career full of hopes that Metaphysics would prove a useful mentor, if not a guide in science. I soon found, however, that it availed me nothing, and I long ago arrived at the conclusion so well put by Agassiz, when he says: 'We trust that the time is not distant when it will be universally understood that the battle of the evidences will have to be fought on the field of Physical Science, and not on that of the Metaphysical.'" This was the difficult lesson of the period when Evolution was born. Hooker learned the lesson early. He cleared his mental outlook from all preconceptions, and worked down to the bed-rock of objective fact. Thus he was free to use his vast and detailed knowledge in advancing, along the lines of induction alone, towards sound generalisations. These had their very close relation to questions of the mutability of species. The subject was approached by him through the study of geographical distribution, in which, as we have seen, he had at an early age become the leading authority.

The fame of Sir Joseph Hooker as a philosophical biologist rests upon a masterly series of Essays and Addresses. The chief of these were "The Introductory Essay to the *Flora Tasmaniae*, dealing with the Antarctic Flora as a whole"; "The Essay on the Distribution of Arctic Plants," published in 1862; "The Discourse on Insular Floras," in 1866; The Presidential Address to the British Association at Norwich in 1868; his Address at York, in 1881, on Geographical Distribution; and finally, "The Essay on the Vegetation of India," published in 1904. None of these were mere inspirations of the moment. They were the outcome of arduous journeys to observe and to collect, and subsequently of careful analysis of the specimens and of the facts. The dates of publication bear this out. "The Essay on the Antarctic Flora" appeared about twenty years after the completion of the voyage. "The Essay on the Vegetation of India was not published till more than half-a-century after Hooker first set foot in India. It is upon such foundations that Hooker's reputation as a great constructive thinker is based.

The first-named of these essays will probably be estimated as the most notable of them all in the history of Science. It was completed in November, 1859, barely a year after the joint communications of Darwin and Wallace to the Linnaean Society, and before the "Origin of Species" had appeared. It was to this Essay that Darwin referred, when he wrote that "Hooker has come round, and will publish his belief soon." But this publication of his belief was not merely an echo of assent of Darwin's own opinions. It was a reasoned statement, advanced upon the basis of his "own self-thought," and his own wide systematic and geographical experience. From these sources he drew for himself support for the "hypothesis that species are derivative, and mutable." He points out how the natural history of Australia seemed specially suited to test such a theory, on account of the comparative uniformity of the physical features being accompanied by a great variety in its flora, and the peculiarity of both its fauna and flora, as compared with other countries. After the test had been made, on the basis of study of some 8000 species, their characters, their spread, and their relations to other lands, he concludes decisively in favour of mutability and a doctrine of progression.

How highly this Essay was esteemed by his contemporaries is shown by the expressions of Lyell and of Darwin. The former writes: "I have just finished the reading of your splendid Essay on the Origin of Species, as illustrated by your wide botanical experience, and think it goes far to raise the variety-making hypothesis to the rank of a theory, as accounting for the manner in which new species enter the world." Darwin wrote: "I have finished your Essay. To my judgment it is by far the grandest and most interesting essay on subjects of the nature discussed I have ever read."

But besides its historical interest in relation to the species question, the Essay contained what was up to its time the most scientific treatment of a large area from the point of view of the plant-geographer. He found that the Antarctic, like the Arctic, Flora is very uniform round the Globe. The same species in many cases occur on every island, though thousands of miles of ocean may intervene. Many of these species reappear on the mountains of Southern Chili, Australia, Tasmania, and New Zealand. The Southern Temperate Floras, on the other hand, of South America, South Africa, Australia, and New Zealand differ more among themselves than do the Floras of Europe, Northern Asia and North America. To explain these facts he suggested the probable former existence, during a warmer period than the present, of a centre of creation of new species in the Southern Ocean, in the form of either a continent or an archipelago, from which the Antarctic Flora radiated. This hypothesis has since been held open to doubt. But the fact that it was suggested shows the broad view which he was prepared to take of the problem before him. His method was essentially that which is now styled "Ecological." Many hold this to be a new phase of botanical enquiry, introduced by Professor Warming in 1895. No one will deny the value of the increased precision which he then brought into such studies. But in point of fact it was ecology on the grand scale that Sir Joseph Hooker practised in the Antarctic in 1840. Moreover, it was pursued, not in regions of old civilisation, but in lands where Nature held her sway untouched by the hand of man.

This Essay on the Flora of the Antarctic was the prototype of the great series. Sir Joseph examined the Arctic Flora from similar points of view. He explained the circumpolar uniformity which it shows, and the prevalence of Scandinavian types, together with the peculiarly limited nature of the Flora of the southward peninsula of Greenland. He extended his enquiries to oceanic islands. He pointed out that the conditions which dictated circumpolar distribution are absent from them; but that other conditions exist in them which account for the strange features which their vegetation shows. He extended the application of such methods to the Himalaya and to Central Asia. He joined with Asa Gray in like enquiries in North America. The latter had already given a scientific explanation of the surprising fact that the plants of the Eastern States resemble more nearly those of China than do those of the Pacific Slope. In resolving these and other problems it was not only the vegetation itself that was studied. The changes of climate in geological time, and of the earth's crust as demonstrated by geologists, formed part of the basis on which he worked. For it is facts such as these which have determined the migration of floras. And migration, as well as mutability of species, entered into most of his speculations. The essays of this magnificent series are like pictures painted with a full brush. The boldness and mastery which they show sprang from long discipline and wide experience.

Finally, the chief results of the phyto-geographical work of himself and of others were summed up in the great address on "Geographical Distribution" at York. The Jubilee of the British Association was held there in 1881. It had been decided that each section should be presided over by a past President of the Association, and he had occupied that position at Norwich in 1868. Accordingly, at York Hooker was appointed President of the Geographical Section, and he chose as the subject of his address "The Geographical Distribution of Organic Beings." To him it illustrated "the interdependence of those Sciences which the Geographer should study." It is not enough merely to observe the topography of organisms, but their hypsometrical distribution must also be noted. Further, the changes of area and of altitude is exposed land-surfaces of which geology gives evidence, are essential features in the problem, together with the changes of climate, such as have determined the advance and retrocession of glacial conditions. Having noted these factors, he continued thus: "With the establishment of the doctrine of orderly evolution of species under known laws I close this list of those recognised principles of the science of geographical distribution, which must guide all who enter upon its pursuit. As Humboldt was its founder, and Forbes its reformer, so we must regard Darwin as its latest and greatest law-giver." Now, after thirty years, may we not add these words of his, that Hooker was himself its greatest exponent?

And so we have followed, however inadequately, this famous man into the various lines of scientific activity which he pursued. We have seen him to excel in them all. The cumulative result is that he is universally held to have been, during several decades, the most distinguished botanist of his time.

He was before all a philosopher. In him we see the foremost student of the broader aspects of plant-life at the time when evolutionary belief was nascent. His influence at that stirring period, though quiet, was far-reaching and deep. His work was both critical and constructive. His wide knowledge, his keen insight, his fearless judgment were invaluable in advancing that intellectual revolution which found its pivot in the mutability of species. The share he took in promoting it was second only to that of his life-long friend, Charles Darwin.

THE ROMANCE OF MATHEMATICS.

By F. T. DEL MARMOL, B.Sc. (Paris), C.E. (Madrid).

Cambridge, with its glorious scientific history, has had under the hospitable roof of its University the fifth international congress of mathematics, presided over by Sir George Darwin, and attended by many eminent mathematicians of the world.

The most interesting of all the speeches has been the presidential address, the culminating point of which was the distinction established by Sir George between pure and applied mathematics, showing clearly the superiority of the former, which never err in their results, while deductions made from their applications to other sciences must depend upon the greater or lesser exactness of the hypotheses on which the applications are based. As an example the chairman quoted the marvellous and complex calculations of Lord Kelvin, who conceded a superior limit of less than one hundred million years as the age of the solid mass of our globe, while geologists, after observing the different terrestrial strata, insisted, and still do so, on a minimum of eight hundred million years. At the present time the conclusions of Kelvin have been generally rejected. Professor Strutt has demonstrated conclusively, from a study of the properties of radio active bodies, that this limit must be at least seven hundred and eleven million years, a figure which agrees fairly well with that put forward by the geologists. The error of the great mathematician may be easily explained: firstly, he was dealing with a problematic ground sown thickly with hypotheses and more or less contradictory facts; secondly, when Lord Kelvin made his calculations, the extremely modern theories of radio-activity were unknown. But it would be unjust to put the blame on the science of mathematics for this or for similarly unsatisfactory results. The calculations of that great man, whom many called the second Newton, were always marvellous. But as in this particular case he had to work out the problem with incomplete data, the results were necessarily defective.

Many similar cases might be cited. There have been few mathematicians worthy of being compared with Laplace and Lagrange, who imagined they had proved the absolute stability of the solar system, when there is no such stability. The calculations of the two great Frenchmen remain a model of elegance and rigorous precision. Unfortunately, they started from false premises: they supposed that all the bodies of the system possess an absolute rigidity, whereas there is no star absolutely rigid. If they were so, then Lagrange's famous prophecy regarding the eternal duration of the solar system would be true. Rightly did the chairman of the Congress point out that pure mathematics must not be confused with applied, since, although both aim at truth, the former seeks absolute truth, while the latter essays, often without success, to discover truths about the universe! Sir George Darwin himself has presented astronomers with a most fascinating mathematical theory of the Moon as born from the Earth, and notwithstanding the rigorous reasoning and the severely accurate mathematics of this illustrious astronomer, it is obvious that his theory can only be true if our planet possessed once the stupendous rotational velocity that Sir George supposes it to have possessed at a certain epoch.

A Frenchman over whose recent death Science mourns to-day, Henri Poincaré, who was the world's first mathematician—with the exception, I believe, of Sir George Darwin, and to whose last works many eulogistic references were made at the congress of Cambridge, succeeded, before his death, in crowning his already gigantic labour by the publication of a powerful work, "Les Hypothèses Cosmogoniques," in which he submits transcendental problems on the constitution and origin of the universe to the test of the infinitesimal calculus. His judgment in most cases is severe, excessively so at times; for we notice that in certain questions where the difficulty rather consists in picking out the true theory amongst several that explain the facts satisfactorily, the author declares that none of the solutions are to his liking. This happens, for instance, in the mathematical study of the problem of the conservation of solar heat, which is accounted for by at least three theories: that of the radio-activity of some elements of the Sun; that of the gravitational pressure of the ether, which is proportional to the quotient of the solar mass by the square of the diameter, and that of the fall of meteorites upon the solar surface, and perhaps also a combination of the three causes. But it must be pointed out that Poincare, like several other men of genius, belonged to the metaphysical school of eternal pessimists who distrust the power of the sciences, including that of mathematics, and go so far as to deny these their faculty of representing absolute truth. Poincaré's tendency at arriving at negative results, makes him sometimes look at problems from so arbitrary a point of view that his conclusions lose a great deal of their value. Thus, in the chapter of the problem of the solar heat, on reaching the mathematical analysis of the theory of the meteoric shower, he resolves his equations by eliminating the factor representing the distance of the Earth from the Sun, whilst he would have reached [illegible] conclusions if he had eliminated the factor representing the velocity of our planet. In short, having [illegible] affirmed the constancy of one product, that of the square of the angular velocity by the cube of the distance, the author implicitly introduces into his calculations (pages 190 and 195 *ibid.*) the arbitrary supposition which allows him, later on, to affirm that the Sun cannot have received the necessary amount of cosmic matter to conserve its heat, without the Earth suffering an acceleration sufficient enough to have been detected.

It was Poincaré who wrote in his celebrated "La Science et l'Hypothèse" this disconcerting phrase: "*Les axiomes de la géométrie ne sont que des définitions déguisées*" (the italics are Poincaré's), and this in order to deprive the most beautiful of the pure sciences of its majestic prestige, and to concede belligerence to other so-called geometries. And then he affirms (page 66) that one geometry cannot be truer than another, but only more convenient ("Une géométrie ne peut pas être plus vraie qu'une autre, elle peut seulement être plus *commode*")—again, the italics are Poincaré's. So that if we believe that one side of a triangle is less than the sum of the other two and greater than their difference, or that the sum of the three angles of a triangle is equal to two right angles, it would not be, according to this way of reasoning, because it is absolutely true, but because it would be more convenient to have it so than to believe that the said sum is equal to more than two right angles (geometry of Riemann), or less than two right angles (geometry of Lobatchewsky).

Now, if we measure the angles in millions of triangles, we shall always see that their sum is equal to two right angles, and the same verification can be made with any other conclusion of pure Euclidian geometry, while we fail to verify the conclusions of the pseudo-geometries. Of course, the purpose of those who overlook such facts, is to find a pretext for asserting that it is impossible to find an absolute truth, even in geometry.

We should not forget, by the way, that the school of the impossibilists has been proved wrong on many occasions, and looks like having to sustain a few shocks yet. Pasteur declared that it was impossible to produce by synthesis the substances endowed with the property of polarising light, and yet this synthesis is now a daily affair in laboratories. Auguste Comte was quite certain that man would never know the chemical composition of the stars, and notwithstanding spectrum analysis allows us to analyse a star to-day as easily as we analyse a piece of a mineral.

Louis Favre has rightly said, in his "Histoire Générale des Sciences," that a very interesting "History of Errors" might be written by simply enumerating the supposed impossibilities asserted as such by great men which have turned out in the end to be quite feasible.

There is a "convenience" argument now fashionable amongst many intellectual men, which deals with the rotation of the Earth, and which appears at first sight quite reasonable. It admits the rotation of our planet for the sake of convenience, because there are many facts that support it, and because it is much easier to grant that the Earth revolves around its axis every twenty-four hours than to assume that all the stars revolve around us in one day; but, after all, it is contended, many millions of people, after observing the apparent movement of the Sun, mistakenly affirmed that it was our great luminary which effected its revolution every twenty-four hours; so that this is not a question of pure mathematics, and our belief cannot be called an absolute truth.

To say this, is to overlook the fact that this truth, in common with many others, can be proved mathematically by the application of certain principles of pure mathematics, not to non-exact sciences, but to other purely mathematical principles. For instance, astronomical trigonometry enables us to calculate the distance separating us from Mars, and Kinetics tell us that, in order to revolve round the Earth in twenty-four hours, the red planet would need to possess an orbital velocity of about nine thousand miles a second. Besides, Dynamics tell us that if a body revolves around another, at the mean Martian distance of one hundred and thirty million miles with a velocity of nine thousand miles a second, the central body requires a mass nearly one hundred thousand million times greater than that possessed by the Earth. And since a thing cannot be millions of times greater than itself, we see, by pure mathematical reasoning, that Mars cannot revolve around our planet. And the same reasoning applies to every celestial body except the Moon. For instance, were Alpha Centauri, the nearest star to the solar system, to revolve around us, we should require for our poor little abode a mass many millions of times greater than that calculated by Lord Kelvin for the whole of the visible Universe. So, if we are compelled to recognise that it is not the stars which gravitate around us in twenty-four hours, but that it is our Earth which performs its rotation in one day, we have been forced to accept this conclusion, not only from convenience, but also as an irresistible consequence of a purely mathematical reasoning.

It is not only in such complex matters that mathematics show us their power and their beauty. The simplest problem affords them boundless opportunities. For example, if we ask algebra for two numbers of which the sum shall be four and the product twenty, it gives us as a result two imaginary quantities: the first is two plus the imaginary unit multiplied into four, and the second is two minus the same imaginary unit multiplied also unto four. And yet, though none of these numbers be real, their algebraic sum is four, and their algebraic product is twenty, as required. It is as if this noble and infallible science, while reminding us gently—by giving us imaginary quantities—that we were talking nonsense in asking for such an unreal thing, wants at the same time to show that even things which are physically impossible to us are not outside her powerful grasp. Do they not give us the weight of a double star as easily as scales give us the weight of a loaf?

It is they, the majestic and poetical mathematics, the charming friends who always tell the truth, who never deceive, flatter or discourage, who have pointed out to Professor Bickerton the secrets of the partial impact in the birth of the new stars, they who gave Adams and Le Verrier news of the existence of Neptune before Galle discovered the most remote of the known planets, they, in short, who have whispered to Sir Joshua Thomson the romance of the electrons, those ultimate particles of matter which perhaps the eye of man will never see!

REVIEWS.

ASTRONOMY.

Catalogue of 9842 Naked-eye Stars for the Epoch 1900. By F. W. BACKHOUSE, F.R.A.S.

Sunderland: Hills & Co. Price 10/6 net.

This catalogue was drawn up with a view to the preparation of fourteen large star maps on the gnomonic projection, designed for use in meteoric observations. The author, however, has gone far beyond what was strictly necessary for this purpose, and the volume will be useful to many besides meteoric observers. It contains all the stars that can be readily seen with an unaided eye of normal acuteness in the entire heavens from pole to pole; several are also included which, though individually too faint, might be seen in conjunction with near neighbours. They are arranged by constellations in alphabetical order, and this is not a very convenient plan, for the boundaries of the constellations are irregular and differ in different atlases, besides which the mapping of a single region of the sky may require consultation of several constellations in widely different parts of the book; arrangement by Right Ascension in the usual manner of star catalogues would have been more convenient.

Very full details about the stars' nomenclature and magnitude are given; seven different columns are taken up with the Greek or Roman letters, and the numbers in various catalogues. Then twelve columns contain the estimates of magnitude by different authorities, and the finally adopted magnitude, using the Harvard scale. This is given to the nearest tenth of a magnitude. The positions for 1900 are given to the nearest tenth of a minute of time in R.A., and the nearest minute of Declination. This is near enough for identification, but necessitates reference to some other catalogue if an accurate position is required.

A column of remarks gives notes about variability, and large discordances in the magnitude by some authorities. One obvious use of the catalogue is to rapidly construct a chart of the region round some Nova or Variable, with definitive magnitudes of the stars included. I used it in this way for Nova Geminorum last spring, and found it very convenient. A series of maps is promised containing all the objects in the catalogue. I have not yet seen these, but from the description given I have no doubt that the combined work will be of great service to a wide circle of astronomers, and will do much to stimulate the study of the brighter stars.

A. C. D. Crommelin.

Observatoire Royal de Belgique: Annuaire Astronomique pour 1913.—By G. Lecointe. 516 pages. 6 illustrations. 7-ins. × 5-ins.

(Brussels: Hayez.)

This forms a serviceable handbook of general astronomical information. It has copious extracts from the *Nautical Almanac*, giving positions of Sun, Moon, planets, satellites, stars, eclipses, and so on, also refraction and tide tables, elements of planets, comets, and so on; an essay on the measure and determination of time, others on recent progress in astronomy, the eclipse of last April, variable stars, terrestrial magnetism. There are reproductions of photographs of Comet 1910 I and of the spiral nebula in Canes Venatici. Altogether a convenient work of reference.

A. C. D. C.

BIOGRAPHY.

The Early Naturalists. Their Lives and Work. (1530–1789).—By L. C. Miall, D.Sc., F.R.S. 396 pages. 9-in. × 6-in.

(Macmillan & Co. Price 10/- net.)

There is always a tendency more or less to neglect the ladder up which one has climbed; but it is surely part of the education of a scientific man to know something of the steps by which his subject has progressed, something of the men, whose labours formed the foundation and indeed built the edifice of his science. There is so much to do at present, however, that there is little time to give to thought even of the future, let alone to the past, and it is difficult for busy people to study in full detail the life of the great workers who have gone before. For biologists, however, something has been done, for Professor Miall has spent his leisure in surveying the lives of the early naturalists; from Otto Bruntels, who was born in 1484, down to Buffon, who died in 1788, and not only has he written an account of their work, but also in most cases given a carefully considered estimate of their character and of the part which they have played in the building up of biology.

Quite as interesting as the discoveries which were made are the records of mistakes, and there are hosts of interesting notes which illuminate the book as one goes along, dealing with such facts as that the early naturalists could only get their training in the medical school, and that many also found the easiest way to earn a living was to practice medicine. Professor Miall has laid all naturalists under a deep obligation.

Wilfred Mark Webb.

BIOLOGY.

British Plant Galls.—By E. W. Swanton. 287 pages. 32 plates (16 being coloured). 7¾-in. × 5¼-in.

(Methuen & Co. Price 7/6 net.)

Very much interest is aroused by galls; very little of a popular character has been written upon them; the result is that the ordinary lover of nature knows practically nothing about them, and the naturalist's ideas are more hazy than they otherwise would be.

Mr. Swanton's efforts to bring together what is known about our British galls are worthy of the highest commendation, and the book which is the result will prove exceedingly useful. It may also lead to more attention being paid by amateurs, who often have the most time to give to such matters, to the study of galls. There is a variety about the subject which it is difficult to equal; the growths are vegetable and arise from the stimuli supplied by animals. Sometimes the species of the latter is only to be determined by the appearance of the galls. The "causers," as Mr. Swanton calls them, may belong to many orders of insects, to the mites, to the eel worms, to fungi, and those to whom the continuous study of a single order or group does not appeal will have the satisfaction of jumping first to one and then to another in dealing with galls.

The alternation of generations which is seen in some of the gall causers is a fascinating subject, and we foresee for Mr. Swanton's book a wide circulation.

From a scientific point of view the classified and descriptive catalogue of British Galls is a most valuable addition to works of reference and the basis of classification is a botanical one, as the majority of British naturalists have some knowledge of our native plants. The first catalogue of British plant galls, published in 1872, contained ninety-one galls; in 1898, Mr. Connold described four hundred and twenty five, and in the present catalogue more than eight hundred are dealt with. Mr. Swanton appeals for criticisms and specimens with a view to making a second edition of the book more perfect. There is an abundance of coloured and other illustrations; the preface written by Sir Jonathan Hutchinson is another point of interest. The position of the so-called "crown galls" is discussed in this, Sir Jonathan being of opinion that they should be divided from the rest and placed with diseases known in England under the name of "canker."

Wilfred Mark Webb.

CHEMISTRY.

Oil Finding.—By E. H. Cunningham Craig, B.A., F.G.S. With an introduction by Sir Boverton Redwood, Bart. 195 pages. 13 plates. 18 figures. 9 in. × 5¾-in.

(Edward Arnold. Price 8/6 net.)

This book will appeal to several classes of readers, for the geologist will here find an able description of the structure of the formations in which petroleum deposits occur, while the chemist will be interested in the chapters discussing the origin and mode of formation of petroleum.

The author's descriptions are not merely impersonal outlines, but are also clever criticisms of the different theories that have been brought forward. He himself strongly favours the view that "every hypothesis but that of the origin from terrestrial vegetation fails when tested by an appeal to the facts to be observed at the present day."

The book is well illustrated, and has a preface by Sir Boverton Redwood, in which attention is called to the value of the book as a means of assigning the true value to the flowery estimates of the oil company promoters.

C. A. M.

METAPHYSICS.

Studies in Jacob Boehme.—By A. J. Penny. 475 pages. 2 plates. 9¼-ins. × 6-ins.

(John M. Watkins. Price 6/- net.)

One of the marked characteristics of the present century, distinguishing it from that immediately preceding, is to be [illegible] the attitude of scientific men towards the problems of philosophy. The extraordinary rapid progress made in physical science during the nineteenth century created a false atmosphere of credulity and [illegible], in a belief that all the important facts of the universe were known (only details remaining to be filled in), and that the metaphysical system known as materialism had uttered the last word as to the constitution of the Cosmos. Recent discoveries, both in physics and psychology, have shown that this conclusion was too hasty, and the philosophical conception of scientific men to-day is distinctly transcendental and idealistic. Scientific men, therefore, are more likely to be interested, nowadays, in the philosophy of Jacob Boehme, than would have been the case had their attention been called during the past century to a book like the one now under review.

The present volume forms a supplement to a re-issue of Boehme's works now taking place under the general editorship of Mr. C. J. Barker. Mrs. Penny's essays are by no means free from defects. Of course, one cannot expect the same quality of finish in essays reprinted from periodicals as one would have expected had the authoress lived to write a book in exposition of Boehme's system. But apart from this fact, her sparseness of critical powers, her lack of scientific knowledge, and her habit of treating too seriously the utterances of quite unimportant people, lessen her value as an expositor of Boehme. On the other hand, few persons indeed have studied Boehme to the extent that Mrs. Penny did, and she certainly possessed a valuable knack of bringing together passages from Boehme which mutually enlighten each other. When studying a writer so obscure in style as Boehme, every help is valuable, and Mrs. Penny's book may certainly be recommended to sympathetic readers, though they may not invariably agree with her interpretations of Boehme's theories.

Boehme's theory of the seven properties of Nature is particularly interesting, once one becomes used to his quaint terminology, borrowed largely from the alchemists. It permits of both a metaphysical and a physical application. In its former aspect it asserts that all objective existence is the result of desire operating through imagination and will, and thus approximates to the widely-held philosophical doctrine that the so-called objective world is an ideal construction of the perceiving mind. In its physical aspect there is, perhaps, some vague and slight foreshadowing of the theory that matter is generated by the formation of stress centres, or centres of contraction, in the ether.

H. S. REDGROVE.

THE BRITISH ASSOCIATION AT DUNDEE.

THERE is no doubt but that the Dundee Meeting of the British Association was a decided success, and quite apart from the energy, skill and tact of the local organisers there is one outstanding reason why the meeting was a large one.

Dundee is more than two or three hours' journey from London and indeed from other centres of activity in England. The distance and the fact that Dundee is in Scotland suggested to would-be visitors that attendance at the meeting would really mean a change and give them the opportunity of taking a holiday afterwards in the Highlands or elsewhere. There was also little to encourage readers of papers to pay a flying visit, make their communication and return home the same or the next day, as was possible at Leicester, Sheffield and Portsmouth. Then again residents at such places as these have had many opportunities recently of easily attending meetings, but it is forty-five years since the Association last met at Dundee, and twenty or so since it went to Edinburgh. These facts explain, no doubt, the large number of local members who were a feature of the meeting. The same results were obtained by the Royal Agricultural Society so long as it went sufficiently far from London; but when it made Park Royal its headquarters its annual shows were not a success.

The writer chose the West Coast route, went by the London and North Western Railway to Carlisle, and thence over the Caledonian line to Dundee, missing the Tay bridge, but passing through many lovely stretches of country.

Speaking of the West Coast, it sounds strange when one hears it said that Liverpool is very nearly as far east as Dundee, although they are on different sides of Great Britain. A glance at a map will soon show that this statement is correct.

Turning to the President's address, which by a coincidence was begun on the very day and at the same hour, forty-five years after the last one delivered at Dundee, it may be said that no other communication is so easy to criticise or more difficult to compose. If the speaker talks of his own work he is liable to be, or to be considered, egotistical, and his matter (unless he is one of those scientific men who are out of a groove and is therefore paradoxically not looked up to by his fellows) is likely to be dry and not appreciated by a general audience. The specialist trying to be general is also in difficulties. His scientific hearers are liable to call his address twaddle. As a matter of fact the writer has only heard one presidential address of this kind which really pleased him. This was given to the South-Eastern Congress of Scientific Societies, by Professor Silvanus Thompson. As the Presidents of this Union in many cases occupy the Chair of the British Association it is possible that the latter body may have a treat in store for them.

Professor Schäfer's address at Dundee certainly gave a good idea of what is at present known with regard to the physiological topics on which he touched, and it was generally appreciated by the mass of his audience which was not made up of specialists. In this respect it is certainly to be commended. It was, however, in the opinion of those who know what makes for the success of a discourse, interminably long, and occasionally when Professor Schafer emphasised the fact that he was descending to his audience's level, as when he suggested that few present understood the working of a microscope, his remarks were not pleasing. One cannot help thinking how very different it would have been if Professor Schäfer could have spoken instead of read his address. We look forward to the time when some President will break away from the traditional method and give an address more after the style of the best of the evening discourses. Two of the latter, as usual, were given at Dundee. The writer was not present at the first on "Radiation"; but this seems to have been above the heads of the audience. Professor Keith's was certainly excellent, though a little inclined to be like a sermon, while it was very difficult in a large hall to see the specimens of skeletons and skulls and casts with which he illustrated his remarks on "The Antiquity of Man."

One discussion which attracted considerable attention was that arranged on "The Origin of Life" by Section D (Zoology), partly from its title and partly as it was in a measure dealt with on the subject of the Presidential address. It was useful in that it showed what various opinions are held collectively and individually, though the comment was that no progress had been made. As we outlined in our last number the presidential addresses of the Sections were of more than general interest. That in Section D, by Dr. Chalmers Mitchell, was devoted to the Protection of Animals and Plants in the World generally. Some of the papers in the same section dealt with the matter also, and a good deal was said on the subject at the Conference of Delegates.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

NOVEMBER, 1912.

THE SPIRAL NEBULAE.

By F. W. HENKEL, B.A., F.R.A.S.

PROBABLY no other announcement excited so much interest in the astronomical world about twenty years ago, as that a photograph by Dr. Isaac Roberts of the well-known lenticular nebula in Andromeda (see "KNOWLEDGE," Volume XXXIV, Frontispiece), described by its original discoverer, Simon Marius, as "like a candle shining through horn," and since so often mistaken for a comet, had revealed the fact of its essentially spiral nature. Some there were who thought they saw in this photograph something like a proof of the substantial truth of the Laplacian nebular hypothesis (*e.g.* Darwin's "Mechanical Conditions of a Swarm of Meteorites," 1889). The name nebula, equivalent to the Greek *νεφέλη*, a cloud, was given to cloud-like masses in the heavens, some of which have been resolved into stars, but others are of a totally different character. Next after the nebula in Andromeda, the great nebula in Orion, perhaps the most remarkable of all these objects, was detected by Huygens in 1656. Halley, in 1714, gave an account of six, including the two just mentioned, the nebula in Sagittarius (see Figure 441), the cluster ω Centauri, discovered by himself in 1677, and the cluster in Hercules detected in 1714 (see Figure 440), and finally another in Antinous.

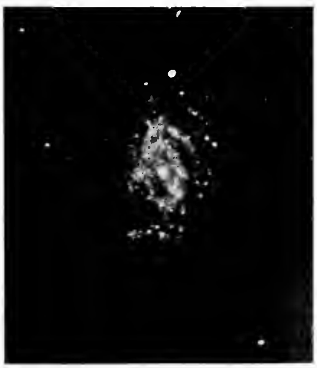


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FIGURE 433.
M. 11730 Ursae Majoris.

FIGURE 434.
H.V. 43 Ursae Majoris.

Professor T. J. J. See.

FIGURE 435.
M. 100 Comae Berenices.

Spiral Nebulae photographed at Lick Observatory.

We find here the first germs of a "nebular theory." Halley supposed the light of these objects to be occasioned by a lucid medium diffused through the ether, differing from ordinary matter. After Halley, Lacaille and Messier gave more extended lists of nebulous objects known to exist in the sky. The last named included one hundred and three in his catalogue of 1784, and the letter M. appended to a nebula (or cluster) indicates its inclusion in Messier's list. But the magnificent work of Herschel resulted in the discovery of a vastly greater number: no less than three thousand, mainly discovered by himself, were registered in his catalogues, and he divided them into a number of different groups. His work was continued and extended by his son, Sir John Herschel, into the Southern hemisphere. The two Herschels,, father and son, so thoroughly and completely worked at this subject, that though many nebulae have been added by others to their lists, few only of these objects are striking, the numerous small faint nebulae now known being visible only by photographic means or the highest telescopic powers. Sir William Herschel made the following classification of these objects into six different groups: (1) Clusters of stars in which the separate stars are distinguishable. (2) Resolvable nebulae, or such as probably would be resolved into stars by increased optical means. (3) Nebulae which show no signs of resolvability. (4) Planetary nebulae. (5) Stellar nebulae and (6) Nebulous stars. To this we must add the sub-divisions of the irresolvable or probably irresolvable nebulae. (1) Annular nebulae. (2) Elliptic nebulae. (3) Spiral nebulae, the most remarkable and perhaps the most numerous of all. (4) Irregular or amorphous nebulae. Amongst annular nebulae the well-known ring nebula in Lyra, Messier 57 Lyrae (see Figure 439) is perhaps the most interesting. It consists of a nearly circular ring of light with a dark central portion. The latter, however, contains some traces of nebulous matter as seen in the largest instruments, whilst the outer edge of the ring is broken by projections of various sizes and shapes. It has been claimed by some that it is at least partly resolvable into stars, whilst the late Sir W. Huggins considered that it is merely a mass of incandescent gaseous or "ultra-gaseous" matter, with individual stars scattered over it. Of elliptic nebulae the most remarkable and interesting was for a long time thought to be the great nebula in Andromeda, but as we have said, the photographs of Dr. Isaac Roberts have brought out its spiral character. Spiral nebulae were for the first time distinctly known to be such when the great telescope of Lord Rosse was brought to bear upon these objects. Thus, the Nebula 51M. Canum Venaticorum (see "KNOWLEDGE" volume XXXIV, page 417), which Sir John Herschel had considered to be a bright globular cluster surrounded by a bright nebulous ring of varying brilliancy, was shown by Lord Rosse to be of a most remarkable spiral form, exhibiting a series of convolutions. Many other spiral nebulae are now known to exist, and they are to be counted by hundreds, if not by thousands, in the starry heavens. 33M. Piscium and 99M. Virginis are, perhaps, the finest after the nebula in Andromeda and the great whirlpool nebula in the "Hunting Dogs." Probably the most beautiful and satisfactory photographs of spiral nebulae ever taken have been obtained at Lick Observatory, California, U.S.A., by Professor Barnard, the late Dr. Keeler and Mr. Perrine, with the Crossley Refractor, and by the courtesy of Dr. See we give reproductions of six of these objects (see Figures

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FIGURE 436.
M. 99 Comae Berenices.

FIGURE 437.
M. 61 Virginis.

Professor T. J. J. See.

FIGURE 438.
M. 88 Comae Berenices.

Spiral Nebulae photographed at Lick Observatory.

433 to 438)—M. 11730 Ursae Majoris, H.V. 43 Ursae Majoris, M. 100 Comae Berenices, M. 99 of the same constellation, M. 61 Virginis, and M. 88 Comae

FIGURE 439.

The Annular Nebula in Lyra.

From a photograph taken at Mount Wilson Observatory, September 17th, 1909, by G. W. Ritchey. Exposure thirty minutes

Berenices. It is only with large instruments and the highest applications of the photographic art that the beauty and wonder of these objects becomes to some extent manifest. With smaller instrumental means but little information can be gathered. The bulk of the objects given in Messier's catalogue have proved to be remote or highly condensed star clusters: only a few of them appear to be true nebulae. It was on account of this resolution by the application of more powerful optical appliances that the idea was once held that the only difference between these objects was merely a matter of greater or less distance, the nearer clusters being shown to be such by small telescopes, the more remote ones proving intractable. The great telescopes of the Herschels and Lord Rosse succeeded in bringing so many of these objects hitherto unresolved into the resolvable class and it was at one time even thought that the great nebula of Orion itself, most wonderful of them all, showed signs of resolvability. On philosophic rather than strictly scientific grounds the idea had been entertained of the existence of a specific form of substance, "nebulous matter," of extreme tenuity and transparency, with feeble luminosity, differing from the solid, liquid, and gaseous conditions with which we are familiar on our planet. From this matter it was supposed all other matter had arisen by slow condensation, and the irresolvable nebulae were formed of this as yet uncondensed material. These views were supported by Halley, to whom science owes so much both in the way of discovery and suggestion: he supposed "the light of the nebulae to be occasioned by a lucid medium diffused through the ether and shining by its own light." Up till quite recently, however, it has been generally considered that all these bodies were continuous masses in equilibrium or revolving slowly. On the Laplacian nebular hypothesis it was supposed that such a mass by slow contraction gradually left behind rings of matter, which collected into separate globes and formed the planets. The nebula of Andromeda was thought by Sir G. Darwin and others to be an actual example of this process going on before our eyes. But when we consider the enormous size and consequently small density of the nebulae in general, we shall understand the difficulty, nay, the impossibility, of any such condition of affairs. The late Mr. Proctor, editor of "KNOWLEDGE," long ago pointed out other objections. "The nebulae we see have, it seems, a greater analogy with the solar corona than with the fiery condensing mists conceived of by Laplace" ("Old and New Astronomy," § 1445). In another place he says: "Whenever enquiry is made into the Laplacian nebular hypothesis, that will be even more decisively rejected." The views of so careful a writer, who took nothing for granted on the authority of others, are worthy of our most scrupulous consideration. Many of the nebulae have an apparent diameter greatly exceeding that of the Sun or Moon, sometimes extending over the greater part of a constellation; but their luminosity is so small that, as we have said, it is only by the highest optical power that the full extent is realised. On the other hand, stars evidently intimately connected therewith

FIGURE 440.

The Cluster M. 13 in Hercules.

From a photograph taken at Lick Observatory on July 13th, 1899, with a Crossley Reflector. Two hours exposure.

have no excessive proper motions, showing that the masses of their nebulae are very small. "The nebula of Andromeda or the great nebula of Orion must exceed in volume the whole space occupied by our solar system, many thousands, perhaps millions, of times." Such enormous objects cannot remain at a high temperature, for their heat would be quickly radiated into space; and consequently the view that the nebulae in general are highly heated masses of fluid in hydrostatic equilibrium is being slowly, but surely, abandoned. Long ago (in 1861) Babinet, of the "Institut," by simple arithmetic showed that no such nebula as Laplace had supposed could have given rise to the Earth and other planets from rings of abandoned matter left behind during its condensation; for the actual speed of these bodies is much quicker than can be thus accounted for, and "the hypothetical solar nebula could not have rotated with sufficient speed to detach the masses." Thus, such a doctrine of the evolution of the planets by separation of rings of matter from the central condensation by rotational instability must be abandoned. Some have proposed as an alternative that secondary condensation nuclei might be formed by *gravitational* instability within the gaseous "nebula": such a doctrine has been outlined by Mr. J. H. Jeans, of Cambridge, in papers which he has contributed to the *Philosophical Transactions of the Royal Society*.

Mainly by the work of Professor See during the last few years a more rational and consistent cosmogony has been built up. We know that there are vast numbers of *spiral* nebulae scattered all over the sky, and it is supposed that our solar system has been formed from such, and not from a spherical or ellipsoidal mass gradually condensing and contracting. Within such a mass, "a discontinuous cosmical cloud, with vortices formed of streams circulating without exerting hydrostatic pressure between the coils" two or more streams of particles, "cosmical dust," meeting give rise to such a spiral nebula, and it is possible that collision and friction between their parts may give rise to a feeble luminosity, as suggested by Sir Norman Lockyer in his "Meteoritic Hypothesis." Two opposite branches of the spirals thus originate by "the meeting of separate streams or by the settling of one stream towards the centre, so that the branches coil up as they condense" (See). The varied forms of spiral nebulae represent various stages in the development of these bodies, and we may thus form some estimate of their relative antiquity. By actual measurement of a number of photographs, however, Professor See has concluded that their forms are only roughly approximate to true geometric spirals, a mixture of the Logarithmic and Archimedean spirals giving an approach to the most common forms observed. "The older nebulae tend to approach the form of the Spiral of Archimedes, the newer more nearly resemble that of the Logarithmic Spiral, but neither form is exactly observed." Many irregularities occur, as might perhaps be expected, so that he concludes that in reality their true forms are "chance spirals, and necessarily depart from any kind of geometric regularity."

From such a system our own has probably developed. Herbert Spencer was probably one of the earliest to point out that a number of flocculent nebulous masses falling towards a centre would assume the spiral form at a time when few spiral nebulae were known to exist (1858). It is somewhat remarkable that Spencer, whose views on many physical questions were so sharply and justly criticized by Tait, J. F. Moulton and others, should have nevertheless held views on some matters in advance of his critics, specialists in their subjects, just as a century earlier Euler, the great mathematician, held more correct views on many physical questions than contemporary physicists. Within this nebulosity processes tending for division are going on. In many cases we have a division into two more or less nearly equal masses and we have then a double star, of which many examples are to be found in the sky. In others the greater part of the material becomes condensed towards the centre, smaller portions only elsewhere, and we have a predominant Sun and comparatively small planets, as in our own system. By degrees much of the rest of the material will be gradually swept up by the larger bodies, but a portion will remain, the comets, meteorites and matter of the Zodiacal Light (?) Meanwhile this, acting as a resisting medium, will render the orbits of the planets and their satellites more nearly circular, at the same time slightly reducing their distance from the central body. Such an action of resistance was well known to Laplace, who gave a mathematical proof of it in his "Mécanique Celeste" (Book X). It has been supposed that Encke's well-known comet, whose return we have recently witnessed, is gradually drawing nearer to the Sun by such an action. However this may be, the secular action of a resisting medium affords the most satisfactory explanation of the present almost perfect circularity of the planetary orbits.

The views we have here briefly outlined invest spiral nebulae with a paramount interest, for in their development, movements and condensation we may trace the processes which have resulted in the evolution of our own solar system. Just as in the forest we observe vegetation in all stages of growth, from the nuts and seeds, through the young and tender saplings, to the full-grown adults, next the "giants of the forest," and, lastly, the moss-grown oaks and decaying remains of former life, so, too, in the starry heavens we may expect to find worlds, past, present, and to come. A favourite scale gave the nebulae as worlds coming into being, white stars, such as Vega, as youthful orbs, our own Sun as a specimen of a later stage, though still intensely hot and luminous; red stars older still in the course of development, the planets and "dark" suns, as hot only in their interiors, and lastly "dead" worlds, like our own Moon. But such an arrangement, though admired and repeated by popular writers, has little support in facts; it is

Figure [illegible]

The Trifid Nebula [illegible]

[illegible]

[illegible] though probably cooler, and older than white ones—they *may* be growing hotter, nor is it by any means necessarily the fact that our own Moon once formed part of an intensely-heated mass. However, the tendency of the human mind cannot be withstood, and hypothesis performs a useful function in serving to coordinate the observed phenomena of nature, and in leading us to search for further evidence, which shall serve as its confirmation, or perhaps lead to its rejection in favour of truer views. The immense amorphous nebulae, of no regular form, such as the great nebula of Orion, the nebula round Eta Argus (now often called Eta Carinae), the Omega nebula, the Trifid nebula in Sagittarius (see Figure 441) and the America nebula (so-called from a rough resemblance in its shape to that of North America) (see Figure 442) may perhaps be regarded as "forming portions of the universal chaos in which order has not yet been introduced." The annular nebulae, planetary nebulae and special nebulae represent a later stage. Professor See suggests that such a nebula as the Ring Nebula in Lyra (see Figure 439) has been formed by the union of two streams, indicated by the blurred ends of their overlapping giving rise to the hazy nebulosity at the extremities of the ellipse. The veil or "gauze over the hoop" perhaps due to wastage from the latter by increasing, may gradually cause it to assume the annular form, a more or less uniform disc of light. The researches of Dr. Max Wolf, of Heidelberg, have shown that at least four different gases are present in this nebula, hydrogen, helium and two other as yet unknown substances, one of which may be identical with the "coronium" of the Solar corona. Dr. Fath, of the Mount Wilson Solar Observatory, has recently examined the question as to the true nature of the spectra given by spiral nebulae generally. It had been generally believed that these bodies usually gave a characterless continuous spectrum unmarked by lines either bright or dark, but the great faintness of their light [illegible] exposure necessary to obtain satisfactory photographs of their spectra. Nevertheless such had been obtained, and the result showed that "no spiral nebula investigated has a truly continuous spectrum." The primary or fundamental part appears to be continuous; but it is interrupted by absorption lines, and in some cases we find bright lines or bands. Thus Professor See infers that this indicates that these bodies, in addition to their gaseous or ultra-gaseous matter, have an abundance of moons and planets scattered throughout their mass; their light may be "due to certain transformations of energy, luminescent effects produced by electric discharges in high vacua and light generated by the impact of the various bodies contained within the nebula." He further supposes that these "moons" arise from the precipitation of ions, and the condensation of cosmical dust on many centres, each such centre being sufficiently distant from any other to be undisturbed by its attraction. After a time in the course of ages many of these "moons" coalesced, and so their number diminished; but the size of the survivors correspondingly increased, impact and collision continually going on. By the impact of numerous smaller bodies, he considers that the characteristic lunar "craters" have gradually arisen, a theory of the origin of lunar surface phenomena quite different from the usually accepted "volcanic" theory, but one which is worthy of consideration and is akin to the views of Humboldt, Gilbert and Proctor on the subject.

If it be indeed the case that our own solar system has developed, not from a nebula of the kind imagined by Laplace, but from a *spiral* nebula which has gradually condensed, and the number of independent members has been reduced by impact and collision to a few whose paths have been rendered nearly circular by the long continued action of the resisting medium, we may learn much of the nature of both spiral nebulae and those of other kinds from the study of the system of which we form a part.

CORRESPONDENCE.

To the Editors of "Knowledge."

Sirs,—I should feel much obliged if any of your readers would enlighten me on the following point.

The minimum of the mean temperature curve for the year does not, of course, occur exactly at the shortest day, but some weeks after. There can be, unfortunately, no parallel with regard to mean nightly minima, but we have the converse case of the two hours lag of mean daily maxima after midday, when the Sun is hottest, which involves the same principle, *viz.*: that, owing to its accumulative properties with regard to heat, the earth and hence the atmosphere, cannot respond at once to a change of intensity in the Sun's radiation. This can be actually observed on a *clear*, calm day with a suitably-placed thermometer. Again, during the solar eclipse last April, the minimum temperature occurred about twelve minutes after the greatest phase. It was an ideal day in London and clear except at first. Only shade temperatures, of course, are referred to. My point is this: Cannot some relation be found between these various lags? Irregularities would surely be smoothed out in over fifty years' average. In the case of the eclipse, I can only put forward that it happened to be a clear day and as such would approach fairly near to an average for similar conditions if it were possible to obtain them. The rate of change of the flow of heat from the Sun is known as regards its annual and diurnal change and, taking the speed of eclipse into account, I take it the resultant rate of change could be calculated for a period during the eclipse. I suppose the earth's properties as regards radiation and absorption may be taken as constant in the three cases.

CALORIE.

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South Hampstead.

LIQUID CRYSTALS.

By F. JOBLING, B.Sc., A.R.C.Sc.

With illustrations from photographs kindly taken by Professor Lehmann.

When it was announced more than a couple of decades ago that substances had been discovered, which, though liquid, exhibited the properties usually associated with crystals, an outburst of adverse criticism was the immediate and not surprising result. After the first stir had subsided, the attitude became one of unreasoning scepticism; the observations themselves were discredited and the disturbing conclusions calmly ignored. Time, however, has favourably modified the trend of scientific opinion, though even to-day, particularly in England, the importance of the subject is not fully realised, and, in consequence, but slight attention is devoted to it. Yet the phenomenon is such a curious and surprising one that whatever interpretation be put upon it, a brief account of its principal aspects cannot fail to be of interest.

After all, only a little consideration is sufficient to demonstrate the reasonableness of the idea of crystallinity in the liquid state. On the orthodox view, a substance which is on the point of undergoing crystallisation has its molecules moving about in the haphazard way which is characteristic of an ordinary fluid, but immediately the temperature at which crystallisation occurs is reached, these are supposed to arrange themselves in a definite order, according to the symmetry of the crystal to be formed. Such a conception, involving as it does the *sudden* formation of cosmos out of chaos, is difficult of comprehension. It must be admitted that it would be far more rational to imagine that, in a liquid as it nears the crystallisation temperature, a marshalling of the molecules is taking place which reaches its culmination at the moment of separation of the solid crystalline form. In other words, the possibility of crystallinity in the liquid state must be conceded. Let us see how far experimental evidence bears out this deduction.

Experimental Evidence.

The discovery of liquid crystals will always be associated with the name of Lehmann, for it was he who stumbled upon the first example, and it is largely due to his persistent activity that we owe the rapid development of the subject.

In 1876, in a series of experiments with his "crystallisation-microscope," to which attention will soon be turned, Lehmann observed that silver iodide, though exhibiting a hexagonal form at the ordinary temperature, changed at 146° into a cubic modification, which was not only plastic but actually liquid. While still dubious as to the exact significance of this isolated instance, Reinitzer in 1888 drew Lehmann's attention to a substance, cholesteryl benzoate, which exhibited a double melting-point: that is to say, on heating, the solid melted at a definite temperature, and this, on further heating, suddenly clarified. The intermediate turbid phase Lehmann found to be at once mobile and doubly refractive; so that taking this in conjunction with his own example, he at once declared for the possibility of the existence of what he has called "liquid-crystals."

Since then, examples have turned up more frequently than might have been anticipated, so that there are now nearly three hundred compounds which can be brought into the same category as cholesteryl benzoate. These compounds are all organic and of very diverse structure; but instincts of compassion, as well as considerations of space, spare the infliction upon the reader of any but the simplest of the weird and wonderful names with which they have been labelled.

Crystallisation-Microscope.

Before proceeding further, some notice must be taken of the instrument to which we owe the discovery of and subsequent investigation upon "liquid-crystals."

A "crystallisation - microscope" is shown in Figure 443. The instrument consists of an ordinary microscope, which is provided with means for raising a substance to any desired temperature, for maintaining it there and for cooling it rapidly to another temperature. The heating is effected by means of a miniature Bunsen burner, A, capable of being swung into position below the centre of the stage. A delicate adjustment, B, comprising a lever moving over a graduated arc, is provided for the regulation of the height of the flame, and by the use of an air-blast, not shown in the figure, the bunsen is convertible into a blow-pipe. Also fitted to the instrument are one or more cooling-blasts, C, mounted usually upon universal joints and fitted with an arc adjustment, D, by means of which the liquid upon the slide can be lowered in temperature at almost any desired rate. It is thus possible, by a suitable combination of both heating and cooling, to conduct a microscopic examination of a substance for quite a long time at a constant temperature. In the modern complicated instruments, the arrangement of the parts is slightly different from that shown in the figure, whilst such additions as water-jackets for the lenses and electric connections on the stage are provided.

Let us now consider any one of the many well-known substances which yield "liquid-crystal" droplets and follow its behaviour under the microscope. A little of the substance—usually in some suitable solvent in order to get isolated crystals is placed between two cover-glasses on the microscope stage and a very gentle heat is applied by carefully regulating the height of the small bunsen flame placed in position beneath the object-glasses. When a clear melt or solution has been obtained, the bunsen is swung out of action and the air-jet then brought to bear upon the slide. In order to observe the formation and development of "liquid-crystals," it is best to rely upon their optical properties. To this end, the nicols are crossed and the field of view carefully observed. When a temperature sufficiently near the temperature of crystal formation is reached, points of light appear in different parts of the field and these gradually increase in size until discs of light are attained, in each of which black crosses can be observed. If the plate be now touched with a needle, the slight pressure is sufficient to cause distortion and as they regain their original shape when the pressure is removed, there remains little doubt as to their liquidity. The appearance of the field at this stage is that of a number of cross-imprinted discs of light resembling wheels, standing out upon a dark background. This continues until the temperature has fallen sufficiently low to have reached the temperature of transition of the liquid into the solid state, when the beautiful prismatic colours, indicative of the attainment of the latter condition, quickly make their appearance and replace the above phenomena.

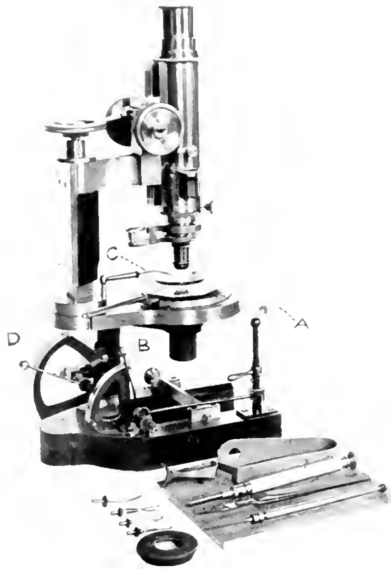


Figure 443.

A simple form of Crystallisation Microscope.

Figure 444 shows the appearance of the field when crystal drops of para-azoxyphenetol in olive-oil are viewed in natural light. A similar field when observed in polarised light is shown in Figure 445, where the dichröism is clearly shown, the two colours being yellow and white. The next photograph, Figure 446, illustrates fairly well the aspect of the field of the same substance as seen between crossed nicols.

A remarkable instance, worthy of special mention, is to be found in ammonium oleate, which Lehmann investigated in 1894. By crystallisation of this substance from alcohol, crystals separate which, notwithstanding their fluidity, form well-defined bi-pyramids, with edges more or less rounded. Figure 447 gives some idea of these regular shapes. That these are really liquid can be tested in the usual way by gently pressing the cover-glass. When two of the bi-pyramids approach one another, they arrange themselves at a certain angle and then slowly coalesce to form a larger single crystal. Yet another noteworthy property lies in their power of growth, since if a crystal be broken in two, each part grows again at the expense of the substance still in solution, and becomes a perfect crystal.

Figure 448 shows another instance, in this case para-azoxy benzoic acid ethyl ester, in which the crystals, though liquid, reveal a definite geometric form. The field is viewed in ordinary light and the crystals are shown in the act of flowing together.

There are even one or two exceptional instances where a substance has been discovered which exhibits a perfectly definite structure bounded by plane faces and sharp angles. In other cases, and these are now becoming quite common, dimorphism makes its appearance: that is to say, the substance exhibits two liquid-crystalline phases and therefore three definite melting-points or, more accurately, transition-points. These dimorphous phases are occasionally rendered evident by their differing degree of turbidity, though usually they are differentiated by their viscosities or other physical properties. Remarkable instances of tri- and even tetra-morphism have recently come to light; but naturally such cases are very rare.

An interesting phenomenon is to be observed when "liquid-crystals" are subjected to the influence of a magnetic field; for under these circumstances the drops rearrange themselves with their principal axes in the direction of the lines of force. This is well shown in Figures 449 and 450, where the former is a reproduction of a photograph of crystal drops of para-azoxy anisol in piperine in natural light, whilst Figure 450 represents the same drops after the magnetic field has been set up. The lines of force are in the direction of sight, and judging from the dark points which have now appeared at the centres, the drops have arranged themselves with their principal axes perpendicular to the paper.

Influence of the Chemical Configuration.

A very noteworthy feature of the liquid-crystalline condition is that it seems to be associated almost

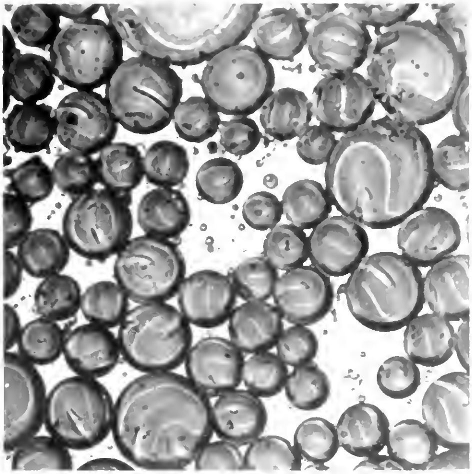


Fig. [illegible]. Liquid crystals [illegible]

Fig. [illegible]. Liquid crystals [illegible]

exclusively with organic compounds and these only of a particular type. Vorländer is the investigator who has devoted special attention to this branch of the subject, having already disclosed many relationships which may have much to do with the elucidation of the phenomenon.

The general conclusion at which he has arrived is that the appearance of "liquid-crystals" is invariably associated with a linear structure of great length, that is to say, with a structure which, when represented three-dimensionally according to the modern tetrahedron arrangement of the carbon [illegible] approximates as closely as possible to a straight line. The oft-recurring para-azoxyphenetol will serve as an example

$$C_2H_5O \cdot C_6H_4 \cdot N = N \cdot C_6H_4 \cdot OC_2H_5$$
$$\quad\quad\quad\quad O$$

In the aliphatic division, therefore, only *normal* compounds are eligible: whilst in the aromatic series, all but *para* substituted compounds are excluded. Bending of the chain such as would be given by an ortho- or meta-compound, or the branching produced

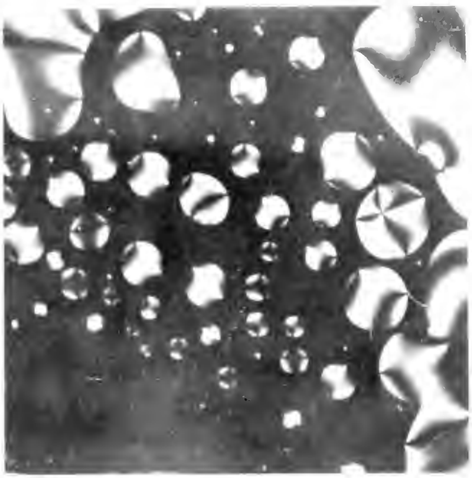


Fig. [illegible]. Liquid [illegible]

Fig. [illegible]. Liquid crystals of ammonium oleate between crossed nicols.

FIGURE 448. Liquid crystals of para-azoxybenzoic acid in natural light, shewing geometric form.

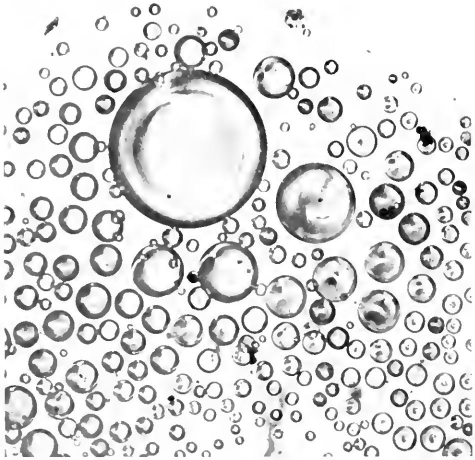


FIGURE 449. Liquid crystals of para-azoxy anisol in natural light.

by substitution, at once dispels all appearance of liquo-crystallinity.

BEARING UPON THE PROBLEM OF LIFE.

Striking similarities have recently been observed between the behaviour of "liquid-crystals" and that of the lowest living organisms. Under certain circumstances, the droplets line up in a chain resembling long fine hairs, which afford a most realistic serpentine movement. This is strikingly shown in Figure 451, where the "apparently living crystals" of para-azoxy cinnamic acid ethyl ester have been photographed in natural light. In spite of the very short time of exposure (one-fiftieth second), the indistinctness of some of the bends clearly indicates that even during this time, considerable undulations of the serpentine folds had taken place.

Add to this curious behaviour the well-known facts that crystals grow and exhibit a certain recuperative power, also that phenomena akin to auto-division and copulation are frequently to be observed among the globules of crystalline liquids, and the resemblance

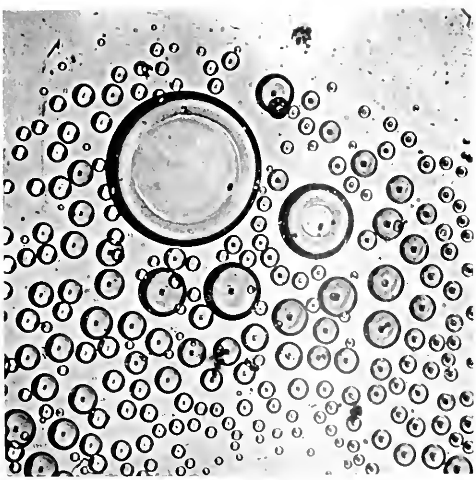


FIGURE 450. The same drop as in Figure 449, but in a magnetic field.

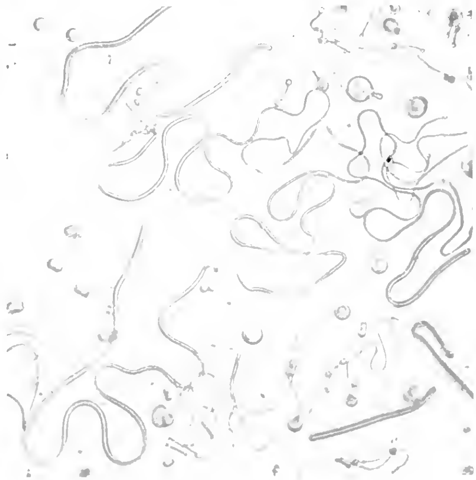


FIGURE 451. "Living crystals" of para-azoxy cinnamic acid ethyl ester in natural light.

to the behaviour of the lower form of life becomes still more complete.

To assert, however, as Lehmann has done, that living growth depends essentially upon the agency of crystallisation, is a conclusion to which all would not care to accompany him. Notwithstanding the array of evidence which he brings forward, much more research and rational consideration are necessary before anything definite can be confidently submitted. As a tentative suggestion, nevertheless, the idea is a striking one and affords an interesting contribution to modern speculation upon the origin and mechanism of life.

Conclusion.

The now acknowledged existence of liquo-crystalline types naturally strikes a blow at our definition of the word "crystal." Hitherto, the term has always been associated with the ideas of rigidity and solidity; but in the light of the evidence above-mentioned, this old idea must be abandoned and one must admit that under certain conditions, a *liquid* may exhibit, if not always the accidental circumstance of form, at least the more important optical properties which are the outcome of a molecular arrangement. In this way, the barrier between the solid and liquid states is partially demolished.

As to what constitutes the *raison-d'etre* of liquid-crystals, the hypothesis advanced by Lehmann appears to be the most likely. Especially is this the case after the failure of the ordinary theory, which attempted an explanation on the basis of a simple emulsion. Lehmann assumes the existence of some directive force, called a "configuration-determining" force, which produces a parallel arrangement of the molecules in spite of the liquid state, and each molecule of the liquid, by virtue of this force, is supposed to be striving to arrange itself as part of a spatial configuration. Vorlander's independent observations lend considerable colour to this notion. If, as he declares, all "liquid-crystal" molecules possess long chain formulae, their shape may be taken to approximate to wires or plates and these will be able to arrange themselves in some definite order. On the other hand, with molecules not so shaped, the space they occupy approximates more nearly to the spherical, and so the liquid, being only a chance aggregation of individuals, will appear isotropic. This probably explains why it is that all liquids do not display crystallinity, though their molecules may be subject to this "configuration-determining" force.

To say more of Lehmann's brilliant achievements, both experimental and theoretical, is not possible within the narrow limits of this article. But from what has been written, it will be gathered that his work constitutes a noteworthy extension of our knowledge of states of matter, particularly of the borderland between the solid and liquid states; and from the many developments which have accrued, the whole subject should be one of surpassing interest, not only to the physicist and the crystallographer, but also to the student of chemistry or of biology.

In conclusion, the author wishes to tender his best thanks to Professor Lehmann himself for the kindness he has shown in specially preparing the photographs which illustrate this article. Readers further interested in the subject are referred to Professor Lehmann's numerous published researches and to his books upon the subject, the chief of which, "Flüssige Kristalle" and "Die neue Welt der flüssigen Kristalle," are well worth consideration.

CORRESPONDENCE.

THE FOURTH DIMENSION.

To the Editors of "Knowledge."

Sirs,—In a letter in your issue of September, Mr. H. Stanley Redgrove states that "by the principle of the continuity of law, or the uniformity of nature . . . . the existence of a third dimension implies that of a fourth, and so on *ad infinitum*," and he argues that belief in a fourth and other dimensions is of the same nature as our belief that the sun will rise to-morrow. Our own unvarying experience of the sun rising every day, as also the unvarying experience of man throughout past ages, tells us that this is a law of nature. We believe that what has occurred in the past will occur in the future. Our experience of dimensions gives us the law that where there is one there must be three, but it gives us absolutely nothing else. There is nothing in it to lead us to believe, or even to suggest to us, that there are other dimensions. There is, consequently, no resemblance between belief in a fourth dimension and belief that the sun will rise to-morrow. Mr. Redgrove refers to detailed arguments for a fourth and other dimensions in a book which he has published. These arguments must be based not on experience but on something else. But experience—some kind of direct perception—is the only possible basis of our knowledge of what exists.

Hendon, N.W. JOHN JOHNSTON.

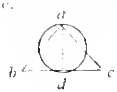
THE TRISECTION OF AN ANGLE.

To the Editors of "Knowledge."

Sirs,—I noticed in a recent issue of your journal a statement by one of your correspondents to the effect that a circle could not be squared by geometric methods.

Now, quite a number of years ago, I ascertained by a geometric diagram or theorem, not shown here, that the circumference of a circle is equal to the perimeter of a triangle the base and altitude of which are each equal to the diameter of the circle.

Roughly



A D and B C equal.

This gives the ratio of the circumference of a circle to its diameter as (using five places of decimals) 3·23606.

Now, can you tell me? Has anyone stated this fact before and demonstrated it.

"GEOMA."

Brisbane.

BIOLOGICAL SCIENCE AND THE PEARLING INDUSTRY.

A paper read before Section D (Zoology) of the British Association for the Advancement of Science at Dundee, on September 5th, 1912.

By H. LYSTER JAMESON, M.A., D.Sc., Ph.D.

In this paper I propose to review, very briefly, the more important attempts that have been made in recent years to apply the science of Marine Zoölogy to the solution of the economic problems presented by the pearl and mother-of-pearl fishing industries, in different parts of the world. The present excessively high price of pearls, and the frequent substitution for them of imitation articles, even among classes who would scorn to wear paste imitations of mineral gems, and still more the amazing price to which the best qualities of mother-of-pearl shell have risen (the best lots reached £550 per ton at the recent London sales) all emphasize the fact that, so far, we zoölogists have not been able to devise a method for increasing production, or for restoring depleted beds of pearl and mother-of-pearl oysters. And yet it cannot be said that we have been stinted for support, or that governments and financiers have in all cases turned a deaf ear to our proposals. Accordingly, while reviewing the work that has been done, I propose to set forth a few ideas, formed as a result of a study of these problems extending over some thirteen years, as to the causes of the small response Biology has made to the demands of industry in this case.

FIGURE 452.

Section of the shell of the Japanese Pearl Oyster showing a "culture pearl" attached.

The chief localities in which biologists and business men have concerned themselves with the question of the application of biological knowledge and theory to this industry are Japan, Mexico, the French possessions in the Eastern Pacific, Burma, the Red Sea, Ceylon, and Australia.

JAPAN.

Japan has gone ahead of all the Western nations and their colonies and possessions in being the first country to establish a pearl-farming industry, based upon a scientific knowledge of the biology and physiology of the mollusc, which has proved itself, after years of trial, to be a firmly founded and highly remunerative business. The two names which are particularly identified with the development of this industry are those of the late Professor Mitsukuri and Mr. K. Mikimoto, an ideal association of the learned scholar and the far-seeing business man. These two pioneers met first at the National Industrial Exhibition in Tokyo in 1890, where Mr. Mikimoto, a pearl merchant, had an exhibit of pearl oysters (*Margaritifera martensii*) from Japanese waters. It was then that Professor Mitsukuri suggested to Mr. Mikimoto the possibility of cultivating the pearl oysters and making them produce pearls.

When Mr. Mikimoto started practical work on the Shima fisheries, he shared the common fate of prophets and pioneers, and was ridiculed by his friends for "throwing his money into the sea." However, meeting and overcoming, one after another, the difficulties that are inseparable from the early stages of such an enterprise, turning for advice to Professor Mitsukuri and Dr. Kishinoue, retaining unshaken his faith in the ultimate attainment of his goal, he saw, within six years of his first meeting with the Professor, his enterprise pass from the experimental to the commercial scale, patented his process, and, at the end of 1898, marketed his first crop of "Culture-Pearls," as these products were named.

The enterprise is carried on in the Bay of Agu, in the province of Shima, and the area leased for that purpose, which amounted to about five hundred acres in 1904, one thousand acres in 1905, is stated to have been extended in 1911 to about twenty-two nautical miles. In 1911 it supported fifty families, whose headquarters is a village situated on a previously uninhabited island.

The operations consist in collecting the young oysters on stones, which are laid down, just before the ascertained spatting season, in areas where there is an abundant spatfall: in laying out the young oysters so collected on more suitable grounds, and, when they have attained a certain size, in operating on them to induce them to produce pearl-like excrescences or blisters. This is done by introducing between the body of the oyster and the shell a bead of mother-of-pearl, which, in the course of time (four years in Japan) becomes coated over with nacre, giving a hemispherical or more than hemispherical pearl-like body, or "Culture-Pearl."

In 1905 the number of oysters operated on per year was from two hundred and fifty thousand to three hundred thousand; but I fancy it is very much larger now. These blisters are used in cheap jewellery for purposes to which half pearls are applicable. I have not figures as to the present production, but it must be very large, as they are becoming extremely common in rings, scarf-pins, studs, and so on in Europe. They are not *pearls*, but *blisters*, and as such their value is small compared with that of real pearls of comparable size. Indeed, their low value leads me to think that it would scarcely be worth attempting to produce them in the majority of British pearl-shell producing colonies, where the labour and other conditions are difficult compared with Japan. There is every reason to think that Saville-Kent's enterprise with *Margaritifera maxima* in Torres Straits, though the production of "pearls" was spoken of, was in reality concerned with producing these "blisters." It has been shown over and over again that *Margaritifera maxima* and other species can be successfully treated after the Japanese method, and it may be added that in the case of *M. maxima* and *M. margaritifera* the growth of the shell is so rapid that the blisters can be produced in a fraction of the time that is required in the case of the Japanese oyster. I am informed that blisters produced in this way in *M. maxima* are being marketed now, in Paris and the United States. Although it has been stated that fancy prices have been given for a few of these, I believe their value will fall to a level comparable to the price of the Japanese article, as soon as their nature is understood by the public; and their production will, in consequence, be found to be unprofitable in the majority of cases.

It is, however, worth while considering whether it would not be practicable (provided conservation was possible) to establish a "Culture-Pearl" industry in some of the rivers frequented by the freshwater pearl mussel in these islands; if, as is possible, there are still areas where all desire for rural home industries has not yet disappeared. The practicability of producing fine blisters in our freshwater pearl mussel was proved by Linnaeus, whose specimens can still be seen at the Linnean Society, including some that are in no way inferior to the Japanese ones. I do not wish to convey the impression that we have here the potentiality of a highly lucrative industry, in which fortunes can be made, but I think the widely-spreading habit of wearing imitation jewellery affords an ample guarantee of a steady market for a product which occupies a position intermediate between the real pearl and the glass and paste imitation, and which, consequently, will meet the needs of those who cannot afford to buy the former, and whose self-respect forbids them to wear the latter.

Most of the people who have produced blisters in the past have hoped to obtain real spherical "pearls" by the same method, or a modification of it. Quite recently Mr. Toyozo Kobayashi, Professor at the Tokyo Higher Technical College, who is associated with Mr. Mikimoto in his enterprise, has informed me that Mr. Mikimoto has produced a few perfectly free spherical pearls in this way, but that the process is too uncertain to be applicable, as yet, on a commercial scale.

I have always held that a modification of the Japanese process could be devised that would yield this result. But I maintain, in view of what is known of the nature of real pearls, that such bodies would not be "pearls" in the strict sense, and I am of opinion that they could be distinguished from the real article. In fact, I doubt very much whether they could legally be marketed as "pearls."

MEXICO.

For many years past work has been carried on with a view to the cultivation of the pearl oyster of the Pacific Coast of America, *Margaritifera margaritifera* var. *mazatlanica*, in the Gulf of California; but unfortunately no satisfactory scientific account of these operations is in existence. The chief company concerned with this enterprise is the "Compania Criadora de Concha y Perla de la Baja California" and the work was initiated by Mr. Gaston Vives, who has been studying the subject for many years. The chief work of the company is transplantation, in which considerable success is claimed, and it appears that elaborate devices are used to protect the young oysters during the early attached stages, on lines not unlike those adopted for the same purpose with the edible oyster in Holland. Efforts have also, apparently, been made to propagate the oysters; but I am not aware that this has proved feasible on a commercial scale.

So far as I know, apart from transplantation, the work has not yet reached the stage which would warrant its being called a commercial success. In 1909 no less than thirty thousand pounds had been spent on the enterprise.

BURMA.

In 1907, when there was a boom in scientific work, owing to the successful promotion and large initial dividend of the Ceylon Company of Pearl Fishers, Professor Herdman was approached by the Burma Government with a view to a biological enquiry there. Professor Herdman assigned the work to two young biologists, who proceeded to Burma and published a report, which, considering the limited time at their disposal, is an excellent survey of the situation.

No very definite proposals were made for applying biological science with a view to increasing production; but the question of the repopulation of the banks was discussed on pages 18-19, and it was suggested that breeding stock should be laid down in a sheltered bay, and the young collected. The objection to this proposal is the impossibility, in almost every case, of securing that the spat, which passes through a fairly long plankton stage in waters where there is often a strong tidal current, will return to the neighbourhood of the parent shells to attach itself.

I must here mention a matter which is regrettable. It is an instance where a regulation has apparently been based upon a scientific theory which is probably erroneous, and consequently the regulation instead of being beneficial is, if anything, harmful. In the "Rules for Lower Burma, under the Burma Fisheries Act, 1905," Sections 61 and 67, the taking of the oyster-eating fishes, *Balistes* and *Trygon* in the pearl fishery districts was prohibited, and fishermen were required, if they caught these fishes accidentally, to return them to the sea. These rules were issued in August, 1907, just after the above-mentioned report was published. They have since been repealed. It is only fair to the authors to say that the recommendation that such a regulation should be framed is not contained in their report; indeed, it is difficult to imagine how and by whom such a recommendation could have been made. At that time these fishes were supposed to harbour the intermediate and adult stages of a worm which was supposed to cause the formation of pearls in the Ceylon pearl oyster, *Margaritifera vulgaris*, but I do not think there was any evidence that the same parasite occurred in the widely different Mergui mother-of-pearl shell, *Margaritifera maxima*. And my subsequent researches have shown that, apart from this rash analogy, the idea that this worm causes pearls even in the Ceylon oyster is highly doubtful. The regulation thus had the effect of protecting what are probably two of the worst enemies of the oyster.

Mr. John I. Solomon, who is not a trained biologist but an engineer, has formed the Burma Shell Company, and started work in the Mergui Archipelago. An attempt was made by him to grow mother-of-pearl oysters in a large tank on the shore of an island; but this was, as might have been expected, unsuccessful. Some success has, however, been achieved in producing blisters on lines similar to those followed in Japan. I have seen some of Mr. Solomon's products, and they are the finest artificially-produced blisters that I have yet met with, and I understand that he is now marketing them; but whether the enterprise will prove commercially successful will depend, in the main, on whether it will be feasible in those waters to produce these commodities at a profit when they fall to a value comparable to that of the Japanese article, as they must do as soon as their nature is understood.

Red Sea.

For some years Mr. Cyril Crossland has been experimenting in the Red Sea for the Sudan Government, studying the marine biology of its waters, with special reference to the three species of Margaritifera that occur there, *viz.*, *M. margaritifera* var. *erythraea*, *M. vulgaris*, and the valueless *M. mauritii*. So far as I know, Mr. Crossland has not yet published an account of his economic work.

French Pacific.

The question of cultivating the "Tahiti" mother-of-pearl oyster (*M. margaritifera* var. *cumingii*) has often been broached, and has been the subject of several scientific missions; but without any considerable results.

Space forbids me to deal with the several missions in detail in this paper.

Ceylon.

My account of the scientific work done here in the last dozen years will be very brief, as I have already dealt with it recently in two papers (*Journal of Economic Biology*, February, 1912, pages 10–22, and *Proceedings of the Zoological Society*, 1912, pages 260–358, plates XXXIII.–XLVII.).

The history of the enterprise is briefly as follows. In 1900, the Ceylon Government, anxious to devise measures for preventing the frequent occurrence of barren years or periods of years, approached the Council of the Royal Society and Professor (now Sir) Ray Lankester, with a view to obtaining scientific advice. As a result, Professor Herdman was sent on a mission to Ceylon, and left behind him, after a couple of month's work on the spot, an assistant to carry on the work initiated by him. Later on the work started by the Government was taken over by the Ceylon Company of Pearl Fishers, Ltd., a company formed largely to give effect to the recommendations made as a result of this mission. The capital of the Company was £165,000, and Sir West Ridgeway, who was Governor of Ceylon when the mission was undertaken, became chairman of the Company. Professor Herdman was retained as scientific adviser to the Company. Briefly summarised the position may be stated as follows: The two remedies recommended as a result of the scientific mission, *viz.*, cultching and transplantation, have so far failed in practice, and the Company is now in liquidation. Moreover, as I have shown elsewhere, the most important scientific discovery claimed, that is to say, the Cestode origin of pearls, is probably a mistake. Extensive faunistic data were collected; but the relation of some of these to the main question is far from obvious.

A speech made by Sir West Ridgeway, on October 27th, 1900, after a paper by the late Mr. Oliver Collett, on Pearl Oysters, read before the Colombo Branch of the Royal Asiatic Society and reported in *The Ceylon Observer* for October 29th, suggested that Sir Ray Lankester saw, in Ceylon's need for scientific guidance, an opportunity for "enriching the scientific world at the cost of Ceylon"; a charge which is all the more unfortunate because probably a more intensive study of the pearl oyster itself, and of pearl production, would have yielded more immediate practical benefit than the very extensive survey of the marine fauna of Ceylonese waters which forms so large a part of the work which has been done.

A remarkable point in connection with this scientific mission was the fact that (except that I myself was invited by Professor Herdman to accompany him as assistant), no serious attempt was made, so far as I know, to secure the co-operation, even in a purely critical and advisory capacity, of the several naturalists (foremost among whom was the late Mr. Saville-Kent) who had already studied the problems connected with pearl oysters and pearls. It is, indeed, implied in a letter from Mr. Saville-Kent published in *The Ceylon Observer* of December 28th, 1900, and in a leading article of the same date, that he was deliberately left out of the councils.

I think that almost every incident in connection with the Ceylon affair, which might be used for the purpose of discrediting zoölogical work, could have been avoided if the assistance of specialists had been invoked.

Turning now to the attitude of the scientific press, I think it is to be regretted that an attempt was made to claim, as due to biological work, certain results that were the result of quite other causes. In *Nature* for July 18th, 1907, there is a review of Professor Herdman's report* in which it is implied that the phenomenal success of the four fisheries which followed upon his visit was due to his scientific investigations. On page *271* there is the following statement:

> "It is very interesting to find that since Professor Herdman's expedition there have been four successive fat years of pearl fishing—the most profitable, so far as is known, that have ever been. . . . . This should surely convince the Philistines that there is something in biology after all!"

and on page *272*, with reference to some observations of Professor Herdman's as to the interrelation of biological phenomena:

> "If this wise saying were as widely accepted as it is certainly true, biological science would find more generous public support, and we should hear no more of impatient criticisms of scientific investigations which do not yield an increase of rupees so rapidly as Professor Herdman's study of the Ceylonese Oyster Beds has done."

I am sure that Professor Herdman would be the first to disclaim this; these fisheries, like previous ones, were the result of natural deposits of oysters, which matured, were discovered in the course of inspection, and were fished when ripe. It is particularly regrettable, in view of the heavy losses which have been incurred by the investing public through the failure of a company which hoped to achieve great results through the aid of science, that an erroneous idea of this kind should have been circulated by a paper of the standing of *Nature*. The other extreme has been reached by the general public, as instanced in the newspaper reports of the meetings of the Company, where the failure of the operations is attributed to the bankruptcy of science, a charge as untrue as it is unjust.

AUSTRALIA. (1) MR. SAVILLE-KENT'S EARLY WORK.

The first naturalist to make a serious study of the Australian mother-of-pearl oyster (*M. maxima*), the most valuable of all kinds, was the late Mr. Saville-Kent. Mr. Kent demonstrated the feasibility of transplanting this species from the fishing grounds, and of successfully laying it down in shallow inshore waters.

His results in actual cultivation are vitiated by the fact that he mistook the "bastard shells" (*M. vulgaris* and *M. sugillata*) (see Figures 453 and 454) which can be collected in enormous quantities on suitable catchment in tropical Australia, for the young of *M. maxima* (see Figure 457). This mistake has been made by almost all investigators of this species. The young shells figured by him in his works, "The Great Barrier Reef" and "The Naturalist in Australia," are certainly "bastard shells" and not the young of *M. maxima*.

Mr. Saville-Kent urged the establishment of cultivation on the foreshore, undersized shell being brought in from the grounds and laid down to grow and reproduce. He considered such a stock would breed and multiply; but I have always held that the man who lays down breeding stock, while no doubt a public benefactor, reaps a very small fragment of the harvest himself, the free-swimming young being scattered far and wide before they settle.

In 1894, when the pioneer shellers who worked the industry from "stations" or homesteads scattered about on the various islands were giving place to highly organised fleets, owned by companies in Sydney and Brisbane, some of the shellers themselves tried to induce the Queensland Government to make the bringing in and laying down of small shell compulsory, with a view to founding a permanent white men's industry; but without results.

Mr. Saville-Kent made some experiments in Western Australia in transplanting shell, and he demonstrated that this species could be kept alive so far away from its natural haunts as Shark's Bay. He claims to have bred young oysters from stock he laid down in a mangrove swamp in Roebuck Bay, and figures in his "Naturalist in Australia" the adult shell, with the supposed young attached; but here again the "young" is really another species, *M. sugillata* or *M. carcharianum*, and the assumption that reproduction had taken place was therefore unfounded. In fact, it would seem as if Mr. Kent's oysters had provided the only suitable catchment for some of the larvae of the bastard shell, that happened to pass that way. It would have been strange if the spat produced by these few oysters in this mangrove swamp, through which the tide regularly ebbs and flows, could have found their way back to their parents, after drifting about for days, or perhaps weeks, at the mercy of the tide. I am surprised that biologists and practical shellers have so often based their hopes on this assumption.

* "Report to the Government of Ceylon on the Pearl Oyster Fisheries of Manaar." London: Published by Royal Society, 1903–6.

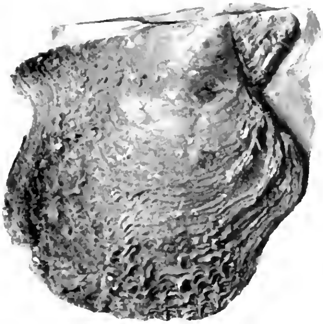


FIGURE 453.

"Lingah" shell (*M. vulgaris* Schumacher), from Torres Straits.

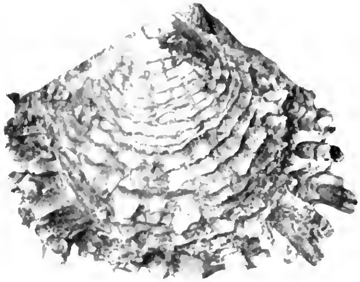


FIGURE 455.

Young of the Black-lipped Mother-of-Pearl Oyster (*M. margaritifera* Linn). Conflict Atoll, Papua.

FIGURE 456.

M. pannisensis Jameson. The "False Spat" that occurs associated with the Black-lipped Shell.

FIGURE 454.

Bastard Shell (*M. sugillata*, Reeve) from Torres Straits.

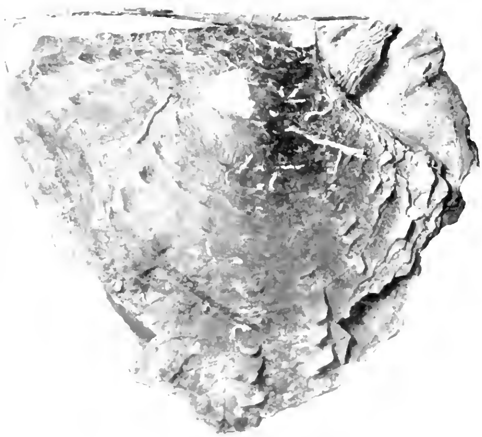


FIGURE 457.

Young of the Australian Mother-of-Pearl Oyster (*M. maxima* Jameson). Montebello Island.

[illegible]

The young of Mother-of-Pearl Oysters compared with other species of the genus *Margaritifera*.

The same argument applies to Mr. Saville-Kent's claim that he got this species to breed at Shark's Bay.

As a result of his success in acclimatising the shell at Shark's Bay, Mr. Kent proposed to introduce it into Houtman's Abrolhos; but I am not aware that this was ever tried. Why people should want to try to introduce this species into extra-tropical localities, for purposes of cultivation, when there are thousands of square miles of suitable ground for this enterprise in the natural haunts of the oyster, I cannot conceive.

(2) THE PILOT CULTIVATION COMPANY'S ENTERPRISE IN TORRES STRAITS.

In 1891, the Queensland Legislature passed an Act permitting the taking of undersized mother-of-pearl oysters; that is to say, examples of less than five inches, nacre measurement, for cultivation purposes (this privilege has since been cancelled). The Pilot Cultivation Company was formed by some of the leading pearling-fleet owners, Mr. James Clark being the moving spirit. An area about two miles long, and varying in width from half a mile to a mile, in the passage between Prince of Wales Island and Friday Island, was leased to the Company. This passage was well known to Mr. Clark, who had formerly had a station there; so that, so far as the experience of a practical man is a guarantee, it may be assumed that it was a suitable place for this enterprise. It had formerly carried rich deposits of shell, which, however, had been cleared off.

The following account of the enterprise is in great part pieced together from what was told me when I visited Torres Straits in 1900, and from the evidence given before the several commissions on the pearling industry. It is difficult to get accurate information, or exact data; indeed, it seems probable that there was some intentional reticence on the part of those witnesses who were personally interested in the venture.

The first attempts at transplanting oysters were made with a sailing vessel, and were not successful, owing to heavy losses, attributed to insufficient circulation of water in the well in which the shells were carried; but with the substitution of steam for sailing power this difficulty was overcome. The oysters were carried on trays in the hold, and the water was kept in circulation by a powerful pump. The loss in transit was estimated to be not more than two and a half per cent., except where delays occurred or the shells were overcrowded on the trays.

I have been unable to obtain exact dates and figures; but it appears that the laying down of shell began in earnest in May, 1894, and from that date something between one hundred thousand and one hundred and fifty thousand young shells, from the area known as the Old Grounds, collected by the divers in the ordinary course of their fishing operations, were laid down. Most of them were under five inches in nacre measurement. It appears from the evidence of a diver employed in the operations that the transplanted shells were simply dumped overboard on the leased area, and no care was taken to lay them down in suitable positions. This procedure cannot be recommended to future cultivators. The shells so laid down were inspected periodically. A lot of dead ones were found, especially among those that had happened to fall on unsuitable ground. The numbers that died ran into many thousands, and it appears that twenty-four cases (about three tons) of dead shell were collected in the course of the experiment.

In August and September, 1897, seven weeks were devoted to fishing these oysters, and thirty thousand or thirty-five thousand were taken up; those marketed exceeded six and a half inches nacre measurement (one thousand four hundred to the ton). As in other cultivation experiments, high hopes were raised by the appearance of quantities of what seemed to be young mother-of-pearl oysters, on the leased area; but these proved to be bastard shell.

A few oysters were left on the ground. I have in my collection one that was taken up in 1900 when I was in Torres Straits.

The law afforded the Company insufficient protection, it being found that it was impossible to convict poachers; the court holding that pearl oysters were *ferae naturae*, a defect which has, I believe, since been remedied in the criminal code.

About the beginning of 1897 the Company introduced a biologist, Mr. S. Pace, who had been trained under the late Professor Howes, at the Royal College of Science. Mr. Pace had had no previous experience of pearl or mother-of-pearl oysters. At first he was engaged in investigations at Goode Island, but subsequently he took up his quarters on the hulk "Dayspring," a vessel which, beginning as a missionary barquentine, had had a highly chequered career before she was moored in Friday Island Passage, as a floating biological laboratory. Mr. Pace has never published an account of his work; but it appears from evidence laid before the Commissions by his employers that such results as he achieved were of academic rather than practical value.

In a report published in the Thursday Island Government Resident's Report for 1898, Mr. Pace proposed the construction of a tank or incubator, perhaps by damming the ends of a channel, in which hand-fertilized ova were to be carried through the pelagic stage, and caught on collectors. Paper anticipations of this kind are common in connection with proposals for the cultivation of mother-of-pearl oysters and edible oysters, but the practical success of such devices has yet to be demonstrated.

With regard to the cost of the Pilot Cultivation Company's enterprise, it is difficult to get anything like satisfactory figures. It is generally claimed by those who carried through the work that it meant a heavy loss to them, and this may be so, if futile experiments and scientific work carried on for an insufficient period be debited against the returns

But, it is probable that the actual cost of collecting, transplanting and raising the shell was considerably more than covered by the price realised by sales.

The work done by this company can hardly be called cultivation. It was simply removing young and undersized shell from the natural grounds and laying them down in more sheltered waters, in order that when they had grown to a profitable size or to a size at which they could be marketed without infringing regulations, they might be economically harvested. As to the scientific investigations, it was absurd to imagine that the problems could be solved in a couple of years by a young naturalist, fresh from college and without previous experience. If success could be achieved so easily as this the prospects of this industry would indeed be alluring!

(3) My Experiments in Papua, in 1899-1900.

From November, 1899, to August, 1900, I was engaged by the lessees of the Conflict Atoll in experimenting with a view to the cultivation of the black-edged mother-of-pearl oyster, *M. margaritifera*, and the introduction into the lagoon of the large mother-of-pearl oyster, *M. maxima*, which occurs around the mainland and larger islands. In the case of the former species, the difficulty centred around the impracticability of obtaining spat in sufficient quantities, the great bulk of the supposed spat obtained on collectors proving to be a worthless species, *M. panasesae*. With regard to *M. maxima*, it does not, in my experience, frequent pure atoll formations, its occurrence in Eastern British New Guinea being confined to the neighbourhood of the mainland, and of those islands which are of a formation other than recent coral.

Several consignments of this species were laid down. Attempts to secure spat from them were not successful, and, while my observations did not extend over a sufficient period to warrant a dogmatic statement, all the indications point to the conclusion that proposals to establish this species in atoll formations, where it is not native, are not likely to meet with success, and I urged strongly at the time that, if the cultivation of this species was to be undertaken seriously, a suitable site on its native grounds should be secured.

The apparent unsuitability of atoll lagoons for this species is perhaps associated with the higher salinity of the water, and the absence of river influence; for my studies lead me to believe that, while an excess of fresh water is injurious to this species, it normally frequents localities where the water is, occasionally or regularly, influenced by minute traces of river water and the detritus which it carries with it.

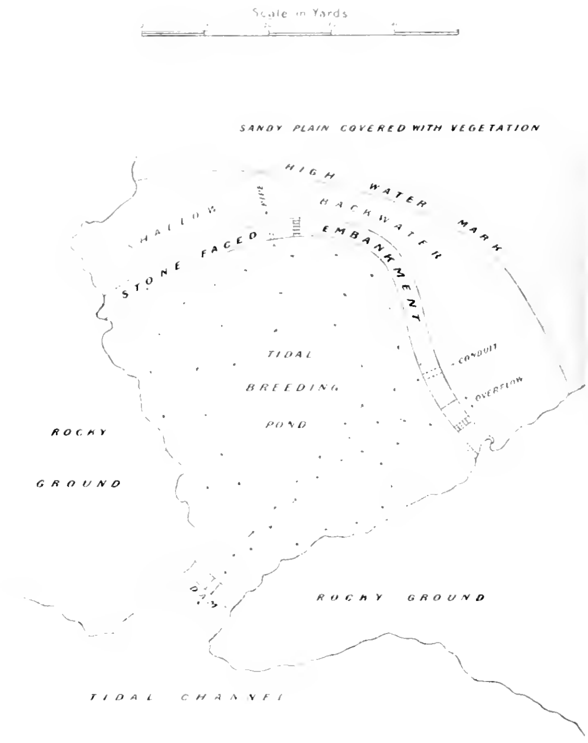
(4) Mr. J. R. Tosh's Work for the Queensland Government.

Mr. Tosh, who had been trained under Professor M'Intosh, at St. Andrew's University, went out in June, 1900, and made Thursday Island his headquarters. There is practically no published record of what he achieved, and there is some reason to think he received inadequate support from the Government. He and I laid down a few young pearl oysters at Badu, in September 1900, with a view to obtaining growth data; but I do not think that these were ever recovered. In 1901, he made proposals for the erection of a laboratory and "hatchery" at Wai Weer, a small island about two miles distant from Thursday Island; but effect was not given to his proposal, although I believe tenders were called for. The laboratory was to include three concrete tanks for experimental work (see note by Professor M'Intosh, in *Nature*, August 15th, 1901), and it is probable that these constituted the "hatchery"—another of the many barren proposals to raise oysters in tanks. Mr. Tosh published a report, of a purely administrative nature, in the Report of the Queensland Marine Department for 1900-1901. The principal recommendations were the closing and opening of the grounds in rotation, as is done in the French Pacific, the gradual reduction of the number of boats licensed, and the raising of the size limit to six inches. He also advocated the adoption of the six-inch limit for the black-lipped shell, which to anyone familiar with that species in Queensland waters will appear quite absurd.

Mr. Millman, the Government Resident at Thursday Island, in his Report for the year 1901, stated that Mr. Tosh "by actual experiment arrived at the knowledge that, given suitable tanks or docks, something like seventy-five per cent. of the enormous number of spat might be saved, and would on removal to proper beds arrive at maturity." If Mr. Tosh achieved this result he has done what practically all other experimenters have failed to do with this and other species, despite many and elaborate experiments. Mr. Millman goes on to say that Mr. Tosh's services were "dispensed with at a time when he was about to fully demonstrate the method of securing and saving the spat emitted in such enormous numbers." It appears in Mr. Millman's report that it was proposed to raise spat in the hatchery at Wai Weer, and to sell the young shell, at six months old, to cultivators, to be laid down on their concessions till it should reach a marketable size. The artificial production of "pearls," apparently on the Japanese lines, was also a part of the scheme, as outlined by Mr. Millman. Mr. Millman also made the statement (I do not know on what authority) that the oyster changes its sex every year; this I believe to be unfounded.

(5) Mr. Saville-Kent's Enterprise in 1908.

About the year 1906 Mr. Saville-Kent obtained a concession for cultivation purposes near Somerset, in Torres Straits, and shortly afterwards formed the Natural Pearl Shell Cultivation Company, Limited, to carry on the cultivation of mother-of-pearl oysters, and the forced production of pearls, according to a "secret process" which he claimed to possess. Mr. Kent treated some oysters for pearl production in December, 1907, and the more extensive work appears to have commenced in February, 1908. Spat collectors were laid down, and quantities of spat were collected, which were, in all probability, only the valueless "bastard" shell. Between May and July of the same year about two thousand oysters were laid down, apparently as breeding stock, with a view to collecting the spat produced by them, on the grounds. This has often been done, and has been taken up by scientific men, who ought to know that it is a forlorn hope. Laying down breeding stock has much to be said in its favour in certain cases where the edible oyster is concerned, especially if the beds are in land-locked waters, where there is little chance of the spat being swept away by the tide; but it is too much to expect that any appreciable percentage of the larvae of the mother-of-pearl oyster, which lives a pelagic life lasting for some days, if not weeks, and which occurs in places where the tidal currents are frequently five knots or more, would return to settle alongside their parents. Of course, the establishment of State breeding reserves, which Mr. Kent advocated in a Report to the Queensland Government in 1905, is quite a different matter, and merits attention.



By permission of T. H. Haynes. FIGURE 458.

Plan of Tidal Pond, showing the course of the current.

Breeding tanks were also installed, presumably with a view to rearing larvae through the pelagic stage. I have already said that this is a project that has never been successfully realized, and proposals of this kind should now cease to be taken seriously, until at least experimental results have been demonstrated.

It appears that the production of so-called "pearls" was the chief object of this Company. The process for producing these was kept a secret, and I believe the documents relating thereto are still in the possession of the successors of the Company. There is, however, good reason for believing that the process was analogous to the Japanese and Linnean processes.

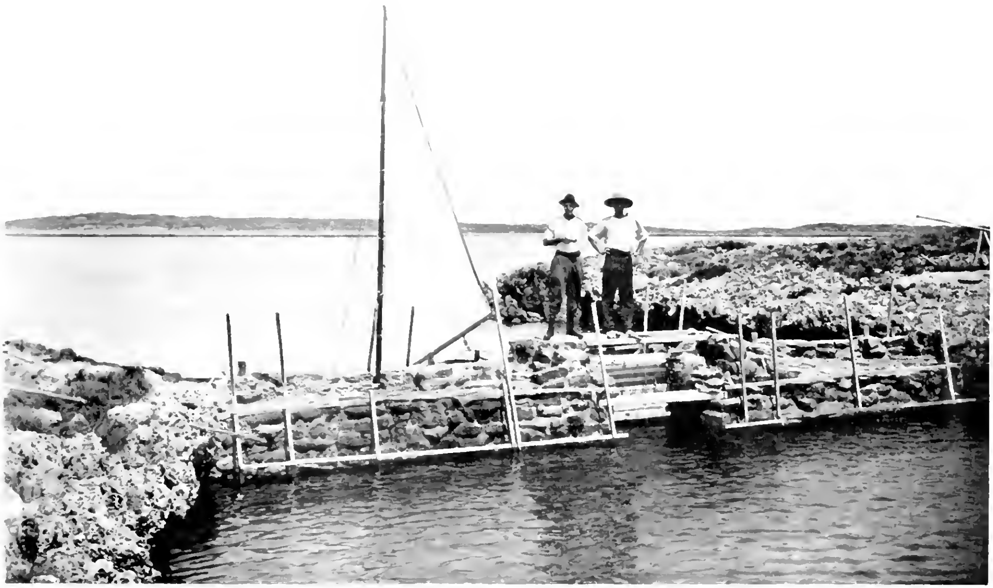
The "pearls" figured in the appendix to the Report of the Queensland Pearl Shelling Commission (1908), and those figured by Saville-Kent in "The Great Barrier Reef," and "The Naturalist in Australia" certainly were. Mr. Saville-Kent once showed me some of these so-called "pearls." I have already given my opinion on the value of such blisters in the beginning of this paper. Their production on a commercial scale in Queensland would, I think, at the best be only practicable as an unimportant adjunct to the cultivation industry.

The weak points in this enterprise seem to have been the supposition that the "bastard" shell was the young of the mother-of-pearl oyster; the too-sanguine assumption that the latter could be bred in tanks; and the confusion between "blisters" and "pearls." The lease was much too short, and the law did not provide satisfactory redress against trespassers. The lease was abandoned in 1909, owing to Mr. Kent's death. Mr. Kent had also some concessions in the waters between Borneo and the Malay Peninsula; but I am not aware that they were developed.

(6) Mr. T. H. Haynes' Experiments in North West Australia.

In 1902, Mr. T. H. Haynes, an experienced pearl-sheller in Western Australia and the East Indies, obtained a concession covering the Montebello Islands, a well-known locality for *M. maxima*. At first he carried on the work as a private concern, but in 1909 the latter was taken over by a syndicate, the Montebello Shell Syndicate, Ltd. The first season in which work was carried on was 1904. A tidal pond, an acre in extent, was made by closing a natural bay with a wall and sluice. (See Figures 458 and 459.) The pond could be emptied by specially constructed syphons. Between two hundred and three hundred shell were laid down in this pond, as breeding stock, and they throve well. No young shell appeared in the pond. Catchment of various kinds was provided. Examples from the breeding stock were examined from time to time, and the maturation of the gonads tested.

Young oysters, of a kind, appeared. The first were seen nineteen days after the breeding stock were laid down; a few were as much as one-eighth of an inch in diameter. These and subsequent deposits of young oysters all died off. It is not possible to say whether they were produced by the oysters in the pond, or whether they were "bastard"



By the courtesy FIGURE 459. A view of the Tidal Pond Dam. *of T. H. Haynes.*

Further experiments were made in 1909-10; but with inconclusive results.

A third and more elaborate experiment was made in the season 1910-11. The particulars of this experiment, given below, were supplied to me by Mr. Haynes. Mr. Haynes had determined that in these waters the spatting season is between October and April. A breeding stock was provided consisting of oysters which had been acclimatised to the waters before the previous season. They were ascertained to have maturing gonads in November, 1910.

As a preliminary to the experiment the pond was emptied, and all fish ejected. Between three hundred and four hundred breeding oysters were introduced. The pond was closed, and the only change of water occurred by the falling of the level some nine inches on the ebb owing to percolation through the bottom, and by the restoration of an equal amount through the sluice on the flood-tide. shell, introduced in the water at flood tide. Mr. Haynes thinks they were young *M. maxima*, produced by his breeding stock, and it appears from a Report by him (Mother-of-pearl Shell Culture, Report to the Directors of the Montebello Shell Syndicate, Ltd., London, 1912) that Mr. Dannevig, the Commonwealth Fisheries Officer, was inclined to share his view; but I am unable to agree with him, though not denying the possibility of his contention. Of course, without specimens it is useless to discuss what species they were; indeed, I know of no character which will allow of the identity of a species of *Margaritifera* being safely diagnosed, at so small a size. There is not, however, satisfactory proof that the breeding stock emitted spawn in the pond, and there is reason to think that at the close of the experiment they had not yet done so. And, although enough is not known of the duration of the free-swimming stage of this species to allow me to say whether the spat found nineteen days after the beginning of the experiment could have been produced in the tank. I lean to the view that this is unlikely, and that these young oysters, whatever they were, had been introduced with the water.

The experiments have for the present been abandoned. Up to date they have cost £6,800, not taking into account the personal services of Mr. Haynes.

The weak point in this work was that it was carried on without scientific assistance. While in a great many cases a scientific man, expected to undertake constructive work and to initiate operations on business lines, fails through lack of previous experience and business instinct, there can be no question that in a case like this, where initiative and resourcefulness, faith in the practicability of the enterprise, and practical and business knowledge were possessed in a marked degree by Mr. Haynes, the advice of a naturalist, concentrating his work on the practical problems which presented themselves, and refraining from dissipating his energy over the intensely fascinating field presented by an unworked tropical fauna, might have made all the difference. Indeed, I have often said to my friend Mr. Haynes that, had he and I had the luck to meet some eleven or twelve years ago, when I was in a position to undertake work of this kind, we should probably both have made our fortunes by now: or, if, as is so often the case, the originators of the enterprise had been "frozen out" and left stranded by the financial gentlemen who generally step in at a later stage, we should have, at any rate, the satisfaction of feeling that our names would go down to posterity as the founders of a new industry.

Other enterprises have been started in Australia, at Beagle Bay and elsewhere; but they have been largely empirical and are thus outside the scope of this paper.

(7) Transplantation of the Australian Mother-of-Pearl Oysters (*M. maxima*) to the Pacific.

A few years ago a Frenchman took about one hundred live mother-of-pearl oysters from Torres Straits to Noumea; but I have no knowledge what became of these.

In the year 1904 Levers Pacific Plantations, Ltd. (to which Company I am indebted for much of this information) engaged Mr. Saville-Kent and transplanted fifteen hundred examples of *M. maxima* from Torres Straits to Suwarrow Island, a distance of about three thousand miles. The transport was carried out successfully, only a small percentage being lost. The oysters were laid down in the lagoon at Suwarrow, which already contained the black-lipped species. The Secretary to the Company informs me that the oysters did not become acclimatised or increase, but gradually died out. Large quantities of small shell were reported as growing on the marine grasses at Suwarrow, but these proved to be a worthless kind, and not the young of the introduced oysters.

The failure of this experiment was only to be expected, and serves to confirm the conclusions I arrived at after my experiments in 1899-1900 at the Conflict Atoll, that this species cannot profitably be introduced into atoll lagoons far from land or river influences.

Besides these actual experiments in the acclimatisation of this species outside its natural haunts, various proposals have been made, casually or seriously. It is obvious that, if such a valuable animal as *M. maxima* could be introduced into a locality where it would become acclimatised and reproduce, it might become a very important new asset. There is no reason why there should not be localities where this species is not native, that possess the necessary conditions to enable it to be established. But, in view of the very special characters of its natural haunts, it would be necessary to treat such proposals with great caution. It appears from Mr. Haynes' report, referred to above, that at one time Mr. Crossland contemplated the introduction of twenty thousand West Australian mother-of-pearl oysters into the Red Sea. I think, however, that it is very doubtful whether this species would live in the Red Sea, where the density and salinity of the water are much higher than on its native grounds.

I understand that the introduction of this species into the West Indies has also been suggested; but it is to be hoped that before expenditure is incurred steps will be taken to obtain advice from someone competent to speak on the matter. The question of its introduction into Ceylon has also been discussed; but nothing has come of it.

When one considers the enormous potential asset that the mother-of-pearl fisheries are to Australia, scattered as they are all along her most vulnerable side, the North and North-West coasts, one is impelled to ask why more has not been done to develop them on lines which would result in the establishment of a permanent white man's industry. In the early days some of these grounds were enormously rich, carrying shell to the value of thousands of pounds to the square mile. These grounds have now been denuded, and fleets and vested interests, valued at hundreds of thousands of pounds, have been built up out of the proceeds of the exploitation of this natural wealth. The industry is now languishing, and is merely an asset for the Japanese and other aliens, save for a margin of profit made by the Europeans, who still finance and nominally control it.

One cannot but ask why Australian statesmen, so far-seeing where other kindred matters of policy are concerned, have not yet seriously invoked the aid of science. I think the reasons are probably twofold. Firstly, there is the effect such a change would have on existing vested interests. There can be no denying that any attempt to initiate conservation and cultivation would be most unwelcome to the present fleet owners, as it would certainly entail the closing of considerable areas of the grounds, and the substitution of individual for common rights thereon. Moreover, the success on any considerable scale of cultivation would be a severe blow to those whose money is invested in the industry as at present carried on, and who would be faced with the necessity of writing off large losses. Secondly, Australians, like the rest of the British people, have perhaps hardly yet realised the strength of zoölogy: that is to say, the immense amount of practical and theoretical information that is available, if it can only be properly mustered and coördinated for the elucidation of their problems. Against this potential strength of our science must be set off the drawback that work of this kind has hitherto been regarded as a fit training for the young and inexperienced man of promise—a useful stepping stone to a post at home—rather than as demanding the best men the Empire can offer.

And yet, to anyone with imagination and faith in the possibilities of his subject, the Australian pearl fisheries offer work of a kind that seldom falls to the lot of a zoölogist. The man who can show how the old and formerly rich beds can be restored as an asset for the white man will be able to see, perhaps not only as a vision but as a reality, the North and North-West coasts of Australia, which are crying out for settlers, peopled with men of his own race—somewhat scattered, perhaps, but none the worse for that—drawing a part of their living from the sea, a part from the soil. To the biologist who can solve the Australian problem there is in store not only the privilege of advancing knowledge and industry but the honour of being numbered among Empire-builders.

A consideration of the small amount that we biologists have so far been able to do to improve the prospects of the pearl and mother-of-pearl fishing industries, and of the immense possibilities of these industries as a field for applied biology, leads one to enquire whether it would not be possible to devise a means for rendering our science more useful, and more directly available to those who may be disposed to invoke our aid. The following suggestion is therefore put forward, tentatively, for the consideration of those concerned with the organisation of science.

Is it not time, in view of the minute and ever-increasing specialisation of our subject, that some kind of machinery were provided that would, when required, bring together and make available for the public, whether Governments, financiers, or shareholders, the available scientific knowledge and advice, on particular subjects such as problems of economic biology? It is seldom, when a new subject like this is broached, that the information necessary to achieve practical results is all in the possession of any one man. Such machinery, if it existed, would be a most valuable asset, never more needed than now, when investors are looking further and further afield for openings for their capital.

What seems to be needed is some organising or coördinating machinery that will bring to bear on a question like this all available reputable specialist opinion that is likely to be useful, both in the preliminary stages, when a plan of campaign is being laid, and in the later phases, when examination, criticism, and correlation of results, and the formulation of a working policy, are required.

It is suggested that if such machinery existed, not only would the prospects of such missions as the Ceylon one, undertaken under the wing of a strong Government, and backed at a later stage by abundant capital, be brighter, and some of the mistakes that have undoubtedly been made in the past be almost impossible, but the public would soon begin to realise that there were available expert "Courts of Appeal" to protect administrations and investors.

Without measures for correlating and concentrating specialist knowledge, the progress of economic biology, as it becomes more and more specialized, will run a risk of being seriously impeded by difficulties similar to those which baffled the builders of the Tower of Babel.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE DISTANCE OF THE MILKY WAY.—I have followed with interest Professor Very's articles on this subject. Time does not permit me to go very fully into the discussion, but I wish to put forward a few considerations which seem to me to make so small a distance very improbable.

(1) We find that the nearer stars have *motus peculiaris* of the same order as the Sun's motion (some twelve miles per second). That the Sun's *motus peculiaris* should without any obvious reason be just the same, both in magnitude and direction, as that of the Milky Way, and that all that countless host should have practically the same motion without any sensible variations, both appear highly improbable *a priori*.

(2) It is well established, by careful counts of star density that this density steadily and continuously increases all the way from the poles of the Milky Way to the Milky Way itself; unless we assume most artificial distribution, this can only mean that the stellar system is flattened like a bun; and if the more distant region were only sixty light years, the nearer portions would be only some twenty light years away, so that all the stars near the poles of the Galaxy should have sensible parallaxes and large proper motions, which is not in accord with a superficial examination of the data.

(3) There are some seventeen stars concluded to have a parallax exceeding one-fifth of a second; that is, within a radius of fifteen light years. We may make some allowance for undetected parallaxes, but we can hardly extend the number above thirty. Taking a radius four times as great, or sixty light years, we should expect to find sixty-four times as many stars, say two thousand; but we actually find about

one thousand million stars in the sidereal system, so that we require a star density in the outer portion more than half a million times as great as in our own neighbourhood, which is certainly an improbable arrangement. Moreover, such extreme crowding would make the mutual gravitation of the galactic stars appreciable, and would render the absence of relative motion still more unlikely.

(4) The nebula round Nova Persei gives us a fairly reliable estimate of the distance of a portion of the Galaxy. We have to make two assumptions, both of which seem to me probable: (*a*) that the nebulosity was rendered visible to us by the reflection of light from the Nova; (*b*) that the Nova was really in the Galaxy, not merely between us and it; this is deducible from the fact that Novae, almost without exception, have appeared in or near the Galaxy. (I think the only exception is Nova Coronae.) It is well known that, even assuming (*a*), the distance of the Nova is not immediately deducible. This distance depends on the angle Earth-Nova-Nebula. Calling this angle ϕ, and calling a the apparent angle through which the Nebula moved outwards from the Nova in a year, a simple trigonometrical calculation gives us the distance of the Nova in light years $\dfrac{\sin(a+\phi)}{\sin a + \sin\phi - \sin(a+\phi)}$

I take a, from approximate measures of the photographs of the nebula, as 14″·6, and deduce the following values of the distance in light years corresponding to different values of ϕ.

ϕ	10	20	30	40	50	60	70	80	90	
Distance	2736	1336	848	616	504	407	336	280	235	light years.

ϕ	100	110	120	130	140	150	160	170	
Distance	197	164	135	109	85	63	41	20	light years.

Kapteyn, from some very probable reasoning based on the forms of the nebular outlines in the photographs, adopts 79° for ϕ (*Astro. Nach.* 3756, and *Pop. Astron.*, 1902, March). This implies a distance of two hundred and eighty-five light years, and a parallax of 0″·011. It seems highly probable that the distance of Nova Persei is not more than some four hundred light years. The small values of ϕ implied by the assumption of a greater distance would imply that the nebula did not surround the Nova, but was several light years on the near side of it, which is an artificial and unlikely configuration.

But a distance of four hundred light years for the nearer parts of the Galaxy is not inconsistent with Newcomb's estimate of three thousand light years for its further parts. It may well have several coils, and their depth in the line of sight may considerably exceed their breadth.

PHOTOGRAPHY OF THE MOON IN ULTRA-VIOLET LIGHT.—Mr. R. W. Wood has been for many years experimenting on the different results obtained in photographing the moon with light of different wave-lengths. He describes his latest results in *The Astrophysical Journal* for July. He uses a nickel-on-glass reflector, and obtains the ultra-violet images by covering the plate with a screen of uviol glass, one millimetre thick, coated with silver; this is opaque to all but ultra-violet rays. For comparison he took ordinary short exposure photographs without any screen (these are chiefly formed by violet light) and orange exposures with Cramer Iso plates and a deep orange screen. He tried the effect of making a three-colour picture from the three negatives, using red, yellow and blue pigments to represent the orange, violet and ultra-violet negatives. He states the result was "a very pretty colour photograph, which brought out the difference of reflecting power of the different maria in a very striking manner. The prevailing tone of the darker portions of the lower surface was olive green, but certain spots come out with an orange tone and others with a decided purple colour."

A remarkable spot near Aristarchus was found to be invisible in yellow light, faint in violet, very dark in ultra-violet. By experiment he found that volcanic tuff stained with sulphur gives this effect and suggests that sulphur had been deposited in that region by a volcanic blast. The new method seems to afford a lever by which, in time, considerable information may be gained as to the constitution of the Moon's surface rocks.

COMETS.—Mr. Walter F. Gale, of New South Wales, the discoverer of Comet 1894 II., found another comet on September 8th last. It has been visible to the naked eye, with a bright nucleus, a considerable coma and a short tail. Perihelion passage 1912, October 4·96, Greenwich M.T., Omega 25° 36′, Node 296° 56′, Inclination 79° 54′, Perihelion Distance 0·7164.

Ephemeris for 11 p.m.

	R.A. H M S	North Decl.		R.A. H M S	North Decl.
Nov. 2.	16 3 47	25 22′	Nov. 14.	16 13 25	33° 25′
„ 6.	16 7 1	28 8	„ 18.	16 16 29	35 58
„ 10.	16 10 14	30 49	„ 22.	16 19 17	38 31

The Comet should be looked for in the West as soon after sunset as it is dark enough. It was visible in October in considerable twilight, but will be much fainter in November, since it is receding from both Earth and Sun.

Tuttle's Comet, whose period is thirteen and two-thirds years, comes to Perihelion about January 3rd next, and will be well placed in December.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

BEES AND GREEN FLOWERS.—As is well known, various flowers are visited by insects despite the absence of white or brightly coloured petals; in fact, some flowers in which the floral leaves are green, like the ordinary foliage-leaves, are visited by bees for pollen. Plateau and other writers on this topic have gone so far as to assert that all flowers might be as green as their leaves without their pollination being compromised. Lovell (*American Naturalist*, 1912), has made various experiments with bees and flowers, and objects to which honey had been added, and from his results concludes that (1) green flowers are not well adapted to insect pollination, many if not all such species having been derived from larger and more highly developed forms by degeneration; (2) any surface, whether bright or dull coloured, on which there is honey will be freely visited by bees after the honey has been discovered; but it will not be discovered so quickly on a surface that does not contrast in hue with its surroundings as on one which does so contrast; (3) the experiments of Plateau on green or greenish flowers are fallacious; (4) when honey-bees are given the choice between a conspicuous and an inconspicuous object under similar conditions, they show a marked preference for the former, and this preference is strong enough to account for the development of colour contrast in flowers.

LEAF-MOVEMENTS IN OXALIDACEAE.—The familiar "sleep-movements" of the leaves of Wood Sorrel and other members of the Oxalidaceae have been investigated by Pfeffer, Darwin, Sachs, and other writers. An interesting account of new experiments on these movements is given by Ulrich (*Trans. Bot. Soc. Pennsylvania*, 1911), who concludes that light plays the most important part in the normal movements of the leaflets of Oxalidaceae, heat and humidity being secondary; the leaflets reach their highest points soon after sunrise, and then sink again for a short time, the rest of the movements during the day depending upon the conditions of their environment; in darkness the movements do not cease until the leaflets have become degenerated; in blue light, leaves usually oscillate less than in white light, but in a week's time they become almost normal; electric stimulations give the most uniform results in experiments, because they can be so accurately repeated; some species assume their sleep position by a series of drops followed by partial recoveries; the rising of the leaflets in the morning is due to the stimulation of the light of the preceding day, which by its constant repetition has made these movements hereditary—they continue, when once inaugurated, in the absence of such stimulation.

SEXUALITY IN YEASTS.—As previously noted in these columns ("KNOWLEDGE," 1911, page 106), the Yeast-fungi (Saccharomycetes) have probably been derived from certain simple sac-fungi (Ascomycetes) which have a definite vegetative plant-body or mycelium consisting of filaments and in which a process of fertilisation occurs prior to the formation of the spore-fruit. Since the publication of the note referred to, several interesting new observations have been made which appear to indicate the existence of a regression series in the Yeasts, beginning with forms in which sexuality is pronounced and ending with completely sexual forms. These observations are dealt with in papers by Guillermond (*Comptes Rendus Soc. Biol.*, Paris, 1911) and by Nadson and Konokotine (*Bull. Jard. Imp. Bot.*, St. Petersburg, 1911).

In the genera *Schizosaccharomyces* and *Zygosaccharomyces* the conjugating cells are alike, and the spores produced after conjugation vary in number from two to eight. In *S. octosporus*, where eight spores (the typical number for Ascomycetes) are formed, the two conjugating cells fuse completely into an ovoid cell, but in other conjugating Yeasts belonging to these two genera the spores are fewer, and may either be all formed in one of the two copulating cells (which after union resemble two retorts with fused necks) or some in one cell and the rest in the other. In *Debaryomyces globosus* the spore-producing cell (ascus) may either arise by copulation as in *Zygosaccharomyces*, or without copulation, or by conjugation of the mother-cell with a rudimentary bud which it has previously given out and which becomes emptied back into the mother-cell. In *Schwanniomyces occidentalis* there is no copulation, but the ascus shows an outgrowth representing a conjugating tube which is functionless. In *Willia anomala* the ascus is formed at the expense of an adult cell which has absorbed the contents of a bud, smaller than the mother-cell, the latter apparently functioning as a male cell—this is similar to the third mode of ascus-formation just mentioned as sometimes occurring in *Debaryomyces*. In *Saccharomycodes Ludwigii* and *Willia Saturnus* conjugation does not take place; but during the formation and maturation of the spores within the mother-cell nuclear fusions occur, which according to Guillermond represent a delayed sexual process.

Nadson and Konokotine describe a new genus of Yeasts, *Guillermondia fluvescens*, in which conjugation occurs between a smaller and a larger cell, the former having been produced as a bud by the latter, which then produces an ascus as an outgrowth; into this the contents of the "fertilised" cell pass, and a single spore is formed, or in some cases two spores.

Though the interpretation of some of these fusions is perhaps an open question, and it is doubtful whether the phenomena described can in all cases be regarded as sexual processes, these recent observations certainly strengthen the links between the Yeasts and the lower typical Ascomycetes, such as *Eremascus* and *Endomyces*, and they also appear to indicate that in the Yeasts, as in the Saprolegniaceae, we have a series of forms showing gradual loss of sexuality.

CHEMISTRY.

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

A TOXIMETER FOR CARBON MONOXIDE.—An ingenious apparatus for detecting the presence of poisonous proportions of carbon monoxide in the atmosphere is described by M. A. Guasco in the *Comptes Rendus* (1912, CLV, 282). It is based upon the fact that when spongy platinum, or platinum black, absorbs carbon monoxide there is a decided increase of temperature. This is made apparent by means of a differential thermometer in the form of a U tube, charged to a certain height with a coloured liquid. Above this tube, and communicating with it, are two bulbs, protected from contact with the atmosphere by a surrounding vessel, but provided with porous membranes through which the gas can pass by endosmosis. One of these bulbs is coated with the platinum black, and any alterations in the temperature produced by the absorption of carbon monoxide are immediately indicated by a change in the level of the liquid in the U tube. The presence of as little as one part in ten thousand of carbon monoxide may thus be detected, and by the addition of a graduated scale the proportion of that gas may be estimated. Or, by substituting mercury for the coloured liquid in the tube, the apparatus may be so arranged that, when a poisonous quantity of carbon monoxide is reached, the expansion of the mercury completes an electric circuit and rings a bell.

USE OF PEAT FOR POWER PURPOSES.—A description is given by Mr. H. V. Pegg in the *Journal of Gas Lighting* (1912, CXIX, 395) of the results of using peat in a gas producer at Portadown. No preliminary drying of the peat was required, although the moisture varied from about eighteen to seventy per cent. according to the state of the weather. The gas produced was of good quality, but excessive spraying with water was necessary to remove the tar, while the plant required cleaning about once a week. The tar appears to be somewhat of a waste product owing to its persistent pyroligneous odour, which has resisted all attempts to remove.

The use of peat instead of coal reduced the bill for fuel by more than fifty per cent. The gas obtained from a peat containing 44·6 per cent. of carbon, 5·42 per cent. of hydrogen and 18·98 per cent. of moisture showed a calorific value of 144·0 B. Th. U., and had the following composition: Carbon dioxide, 10·6; carbon monoxide, 21·0; hydrogen, 13·0; methane, 3·7; and total combustible matter, 37·7 per cent.

VARIATIONS OF NICOTINE IN THE TOBACCO PLANT.—The increasing use of tobacco extracts as insecticides has led to the cultivation of tobacco solely for this purpose. Since the insecticidal value of the preparations depends upon the proportion of nicotine they contain, they are usually bought and sold on the basis of the amount of that alkaloid present. It has, therefore, become a matter of practical importance to ascertain at what period of its growth the tobacco plant is richest in nicotine. In the experiments made by MM. Chuard and Mellet (*Comptes Rendus*, 1912, CLV, 293), with this object in view, it was found that there was a material loss of the alkaloid when the fresh plant was dried.

For estimating the proportions of nicotine in the growing plant, seeds were sown on April 25th, and analyses were made of different parts of the young plants at irregular intervals. On May 15th no nicotine could be detected, but a month later (June 16th) the leaves contained 0·35 per cent., and the roots 0·15 per cent. By August 9th the nicotine in the leaves had increased to 3·12 per cent., and in the roots to 0·69, while on September 18th, the date on which the leaves were gathered, the corresponding amounts were 4·79 per cent. in the leaves and 0·64 per cent. in the roots. The stalks contained about the same proportion of nicotine as the roots, while the amounts in the shoots varied from 0·49 to over one per cent.

Hence, the ordinary method of collection, in which only the leaves are selected, involves a considerable loss of nicotine, and it is suggested that a means might be devised for extracting the alkaloid from the waste portions of the plant, and to utilise the final residues for manure.

NATURAL GASES RICH IN HELIUM.—The gases emitted by some of the French mineral springs are particularly rich in helium, as is shown by the following analyses published by MM. Moureu and Lepape (*Comptes Rendus*, 1912, CLV, 197):—

Spring	Helium in Gas Per cent	Yield in litres per annum	
		Natural Gas	Helium
Santenay, Source Lithium ...	10·16	51,000	5,182
Santenay, Source Carnot... ...	9·97	179,000	17,845
Maizières... ...	5·92	18,250	1,080
Bourbon Lancy ...	1·84	547,500	10,074
Neris	0·97	3,504,000	33,990
La Bourboule ...	0·01	30,484,800	3,048

Assuming that the helium present in these gases was originally derived from the disintegration of radioactive substances, it appears probable that it has not been produced immediately before its emission, but that it consists of gas which may have been formed some time previously from minerals in the vicinity and then dissolved by the water.

It is noted as a curious fact that these and other springs emitting gases rich in helium follow the course of a line extending through Moulins, Dijon and Vesoul.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

EARTHQUAKES AND GLACIERS.—A hitherto unsuspected relation between earthquakes and glaciers has been disclosed by recent work in the Alaskan region. This is fully set forth in Professional Paper No. 69 of the United States Geological Survey. During September, 1899, the region of Yakutat Bay, Alaska, was shaken by a series of severe earthquakes, which were attended by two notable results—great changes in the level of the land incidental to faulting, and remarkable subsequent changes in the adjacent glaciers. Both these remarkable effects entitle this earthquake to be regarded as a type, and as one of the great earthquakes of the world.

The changes of level are the greatest recorded in historical times. The maximum uplift, attested by raised beaches and other phenomena, amounts to over forty-seven feet. Similar measurements of vertical displacements are numerous along the fjords of the region; and not only faulting, but extensive tilting and warping of a complicated character have been demonstrated by these means. Barnacles attached to ledges high above present tide-marks, and amongst land shrubs; mussel shells still attached to rocks a score of feet above sea-level, afford clear evidence of very recent uplift.

Most of the Alaskan glaciers that have been studied shewed, at least up to 1905, distinct evidences of recent recession. Those of Yakutat Bay were found by Professor R. S. Tarr and L. Martin, the authors of the report, to be all in a state of recession when examined in the summer of 1905. In 1906 Professor Tarr returned to the region, and found a most astonishing change. In the intervening ten months many of the glaciers had advanced hundreds of feet, their smooth, moraine-covered surfaces were broken into a jagged sea of seracs and crevasses, and all were notably thickened.

This sudden, spasmodic advance is attributed to the effects of the earthquake of 1899. The Yakutat Bay glaciers are nourished by the normal accumulation of snow and ice over a vast region overhung by craggy mountain slopes on which great masses of snow are lodged in precarious situations. There is first-hand evidence that the great shaking of September, 1899, threw down enormous quantities of snow and ice into the gathering-grounds, and caused what must be regarded as an ice-flood, analogous to a river flood. The latter arrives in the lower reaches of the river in a few hours or days; the ice flood causes a great advance at the foot of the glacier in a few years, the exact time being determined by the rate of flow and the length of the ice. Confirmation of this simple and beautiful explanation is found in the fact that the first glaciers to advance were the shortest. The longest of the Yakutat Bay glaciers have not yet responded to the earthquake shaking. Furthermore "the advance was alike in several respects in all the glaciers it was abrupt and spasmodic, it caused profound transformation of the glacier surface, and it resulted in thickening at the termini—and all the glaciers quickly subsided and returned in a few months to a stagnant state after the effects of the rapid forward movement were spent."

The puzzling fluctuations of the termini of glaciers are usually ascribed to climatic variations; and this is probably the correct explanation in many cases. In earthquakes, however, we have provided an alternative cause of oscillation, undoubtedly operative in Alaska, and probably also in other glacier regions of the world.

PETROLOGY AT THE BRITISH ASSOCIATION.—Petrologists were in force at the Dundee meeting, and many interesting papers were read and discussed.

The seventh and final report of the committee on the composition and origin of the crystalline rocks of Anglesey summarizes a valuable piece of work. In all, forty-three complete rock analyses and twenty-five partial analyses have been made, which alone constitutes a notable addition to British petrography. In this report, a final series of analyses is given, mostly of metamorphic rocks; but one of a "variolitic pillowy diabase" has also been made, which is of interest in comparison with other spilitic lavas, and in view of the interest now taken in the "spilitic suite."

A most interesting discussion followed Dr. Flett's paper on "The Sequence of Volcanic Rocks in Scotland in relation to the Atlantic and Pacific Classification of Suess." The paper dealt mainly with four great groups of volcanic rocks: (1) The Carboniferous, typically "Atlantic" or alkaline in type, with olivine-basalts, trachytes, phonolites, mugearites, and later on teschenites, monchiquites and nepheline basalts; (2) The Old Red Sandstone, consisting mostly of andesites, and with typical "Pacific" or calcic characters; (3) The great Tertiary suite, unquestionably of Atlantic affinities, notwithstanding the Pacific types clustered around certain local centres; (4) The "spilitic suite," consisting of pillow-lavas and their associates, occurring in the Dalradian schists (Tayvallich), and in the Ordovician of the Southern Uplands (see "Knowledge," February, 1912, page 75, and April, 1912, page 152). The spilitic suite is considered by Dr. Flett to constitute a great division of igneous rocks equivalent in value to the Atlantic and Pacific divisions.

The discussion turned mainly on the validity of the Atlantic and Pacific classification, and on the status of the spilitic suite. The nomenclature especially of the former was attacked. Great confusion had been caused, it was alleged, by the use of the terms Atlantic and Pacific in a petrographic sense. They should be restored to their rightful owners, the tectonic geologists and geographers, and petrologists should revert to the terms "alkalic" and "calcic" for their two main divisions. Mr. A. Harker was a notable convert to Dr. Flett's view of the spilitic suite.

Mr. G. Barrow described a case of "magmatic differentiation intensified by dynamic action" in the older granite of Deeside. The granite permeates the crystalline gneisses over large areas in *lit-par-lit* fashion, forming minute sills, which vary from an inch to several feet in thickness. These have proceeded from dyke-like masses exposed in the hillsides. As the sills are traced towards their taper end, oligoclase and biotite steadily diminish in amount, their place being taken by alkaline felspar and muscovite. There is a concomitant increase in grain-size, the taper ends of the sills thus taking on a pegmatitic character. It is clear that under great pressure, the more acid, residual, liquid magma has been separated from, and driven farther into the gneisses, than the less acid, already crystallized material with which it was originally entangled.

Dr. W. Mackie described vesicular rhyolites with beautiful flow-banding, occurring round the Ord Hill of Rhynie, Aberdeenshire. These flows rest on an eroded surface of the diorites and gabbros of West Aberdeenshire—rocks which are considered to represent basic modifications of the younger Grampian granites. The rhyolites are faulted against Old Red Sandstone and are thought to be older than the oldest beds of this series. It seems to the present writer, however, that these rhyolites have a distinctive Old Red Sandstone facies, and may probably be correlated with similar rocks in the Lorne area.

The present writer described the alkaline igneous rocks of Ayrshire, which were recently dealt with in this column ("Knowledge," September 1912, page 342). An additional point of petrographic interest is the demonstration that the zeolitic mineral thomsonite may be of primary igneous origin, since it is found in the syenite of Howford Bridge, Mauchline, with exactly the same characters that give analcite so strong a claim to be considered as primary in this rock.

MICROSCOPY.

By F.R.M.S.

THE HARVEST MITE. I was very pleased to see Mr. Marriage's photomicrograph of the Harvest Mite in the August number of "KNOWLEDGE," page 317, because it entirely agrees with some specimens sent to me by Dr. George, of Kirton Lindsey, in 1908. These specimens were sent to me alive and I made drawings of one, dorsal and ventral surface (see Figures 467 and 468), which was printed with Dr. George's article in *The Naturalist* for September of that year. What makes it still more interesting is that none of the previously published figures I have seen agree so well with Mr. Marriage's photomicrograph as my own. This may be accounted for by there being more than one larval form of the Acarina on the war path at the same time, which is always during the first active part of their existence, the larval stage immediately after leaving the egg. The larval forms of the Hydrachnids are always parasitic at this stage, but not afterwards.

FIGURE 460.

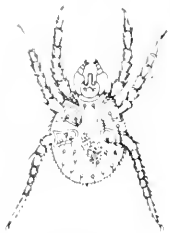


FIGURE 461.

Of course, there is no doubt about it being a larval form of some mite or other; but which mite is the question we have yet to settle. The larvae of *Trombidium holosericeum* and *Trombidium fuliginosum* are both well known. I have a number of each of them myself, but they do not at all agree with the one on page 317. Neither do we know of any one being bitten by either of them. A naturalist in Edinburgh bred some *T. holosericeum* larvae in confinement and placed the living larvae in his stocking but did not succeed in getting bitten. I tried the same experiment this year with *T. fuliginosum* with the same result—no bites. We also know by description and figures a number of larval forms of Trombidiums; but none agree with the larval form which we are sure causes the mischief that to some people is so distressing. It makes one wonder if the irritating little creature is a Trombidium at all. If some one could only succeed in keeping some alive long enough to reach the next stage it might help us very considerably in determining its proper place in the order Acarina. But at present we are quite in the dark as to its proper name, except we know it as *Trombidium autumnalis*.

The superfamily Trombidoidae is divided into six families—Caeciliidae, Cheyletidae, Erythraeidae, Tetranychidae, Rhyncholophidae and Trombididae, and these again into a large number of genera. The adult forms of the Harvest Mites are probably quite well known; it is only our ignorance as to which adult to ascribe the larval forms which does not allow us to give these their proper names. But when we do know, it is no doubt amongst one of the above six families we shall find them.

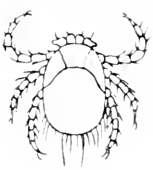


FIGURE 464.

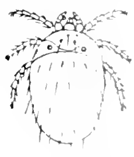


FIGURE 465.

FIGURE 466.

In the Autumn time the Harvest Mite is sure to turn up in person and in print. Some newspaper or other is sure to bring it forward, either seriously or humorously; even *Punch* had a joke out of them in 1907. But, however much has been printed, none have yet helped us to form a correct diagnosis of its true position in the Acarina. The bibliography of the Harvest Mite is very extensive, and covers a wide range of literature. Let us just glance at some of the references which are of easy access to the amateur naturalist.

The earliest account I have found is Baker's "Employment of the Microscope" (1753), page 343, Figure 1. Baker says:—"I have sometimes suspected this little creature might be a young sheep tick from its figure and way of burying itself, but then it should be rather found where sheep feed, than in corn, and before sheep are suffered to come into those fields, and it is never got as I have heard in grass fields, unless bordering upon corn, but amongst wheat it never fails. If any one has a mind to make trial upon this insect, how it comes to be amongst corn only and yet live by sucking of blood, he may easily find abundance of them; for though they prefer the ladies, yet they are so voracious, that they will certainly lay hold of any man's legs that come in their way." Here is the opinion of Baker: he thinks it is a young sheep-tick, and his figures certainly help the conclusion. (Figure 460.)

Gilbert White in Letter XLIII mentions it, but does not attempt to call it anything but acarus.

Kirby and Spence also mention it, but help us no further with the name than *Leptus autumnalis*.

Kuchenmeister gives an account of this mite and a figure by Professor Leuckart. This figure is the nearest to Mr. Marriage's photomicrograph I have seen, and I should think is intended to represent the same creature, but he calls it by the same name as Kirby and Spence. (Figure 461.)

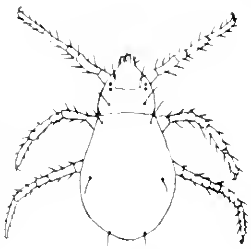


FIGURE 462.

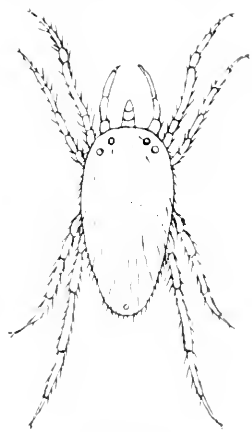


FIGURE 463.

Banks, the American, writing on mites, says it is the larval form of a Trombidium. He does not mention any particular specie, but he gives a figure of the larvae of a Trombidium, which is quite different from the one in question. (Figure 462).

Murray, in "Economic Entomology," calls it *Tetranychus autumnalis*, gives a figure of the same, and takes it out of the family Trombididae; but the figure Murray gives is very different from Mr. Marriage's photograph. (Figure 464.)

The "Micrographic Dictionary," calls it *Trombidium autumnalis*, and gives a figure with eight legs, but says the young form with six legs is frequently met with. (Figure 463.)

"The Cambridge Natural History," Vol. IV., dismisses the the subject in the following few words:—"The Trombididae include most of the moderate-sized velvety red mites which are commonly known as Harvest-mites, and their larvae, the so-called Harvest-bugs, frequently attack man. *Trombidium holosericeum* is a well-known example." No Figure is given.

"Chambers's Encyclopedia" (1901) under Harvest Bug, says it is *Trombidium holosericeum* and gives a figure of the larva and adult. Figures 467 and 468.

It would be quite easy to give a large number of references, but those mentioned will show we are some way from the correct solution yet. We must keep on trying to breed the larval form from adults in confinement of different species of mites until one is found that quite agrees with Mr. Murrice's figure and my own.

CHAS. D. SOAR.

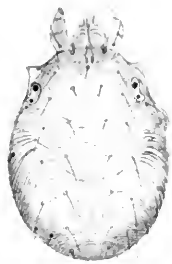


FIGURE 467.
The Harvest Mite × 145.

DARK GROUND ILLUMINATION.

Of late years, microscopists have shown an increasing tendency to favour dark-ground illumination.

To this end, special condensers have been provided, but chiefly for high power work. These have proved to be most efficient in depth of black ground in their defining powers, and also in their illuminating properties. Perhaps it may not be so well known that our ordinary condensers, the achromatics, and the Abbes, are fully as capable of good work as the new dark-ground condensers. They can be specially equipped in this direction for use with low and medium high power objectives. And the cost of this is inconsiderable.

The stand needs a substage fitted with a focusing rack and centring screws. The charm and the comfort of dark ground illumination is undeniable, and when you can add a beautiful effect and perfect definition to these advantages, you have an irresistible combination most desirable to possess.

The materials necessary for this particular system are four or more watch-glasses, called "dead-flats" by the watch-makers. The thinner kinds should be chosen in order to provide room for coloured screen discs to rest in the same carrier. They should fit the carrier easily, yet without looseness. Six thin metal discs, varying in diameter from six-sixteenths of a inch to eleven-sixteenths of an inch, cut out with the lathe from sheet metal and bronzed, is the next requirement.

The nine-sixteenths of an inch disc may be taken to illustrate the process by which the working result is attained.

Spread any good cement, of the nature of seccotine, lightly over one surface of the metal disc, avoiding the actual edge. Place the disc on or about the centre of the glass disc, and put the latter, metal disc downwards, into the condenser carrier.

Remove the upper lens of the condenser, and rack it up as high as it will go under the stage of the microscope. Fit a two inch power into the stand, and arrange the mirror so that the fullest light may pass through the axis of the sub-condenser.

Next, focus the two-inch objective upon the image of the disc, to be seen through the sub-condenser with a ring of white light around it. Then, with the centring screws, place the image of the disc and its surrounding ring of light in the centre of the field, and slowly close the iris diaphragm around the image of the disc. If the disc is not centred with the iris diaphragm, it must be delicately adjusted with the finger tip, or other agent, until the diaphragm sheaves close, and simultaneously shut out the light, all around the circumference of the disc.

When this is accurately done the result can be tested with a familiar slide, mounted for dark ground effects. First, always see, by observing the image of the disc through the objective and condenser, whether it is centred in the field. Then throw out the carrier and centre the fullest blaze of light you can get into the middle of the field by means of the mirror, concave or plane. Replace the carrier and put your slide upon the stage, and focus it with a two-inch objective, or other power, up to one inch.

Now gently lower the sub-stage condenser upon its rack, and the light will increase, the definition will grow, until the full beauty of the subject of the slide is apparent. For this experiment, the iris diaphragm must be fully opened and the top lens of the sub-condenser removed.

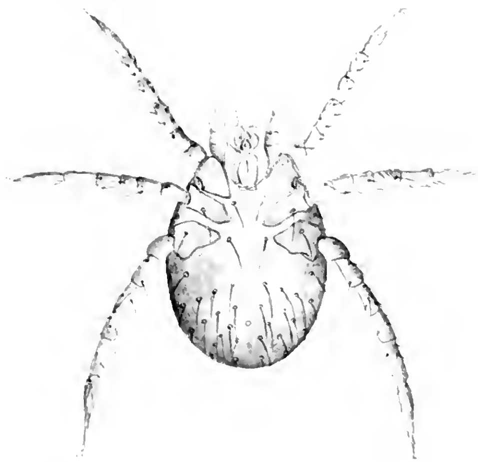


FIGURE 468. The Harvest Mite × 145.

Some condensers may present problems in the matter of focusing the image of the disc and its ring of light. Others, again, have their carriers so placed, that it is difficult to reach the disc underneath with the finger for adjustment, when the iris is being closed around the image of the disc. A little careful ingenuity will overcome all these difficulties. Always use a very low power to search for the image of the disc.

The proper disc for each objective must be found by experiment; try every diameter with each objective. The smaller the disc, the greater the light. Do not attempt to use any power higher than one inch with a divided condenser. The discussion of methods that are used with powers exceeding one inch, and with the complete condenser, may be resumed in another paper.

These methods differ considerably, and give the fullest satisfaction when objectives not exceeding one-eighth of an inch are used.

(REV.) R. FRANCIS JONES.

DIOPSIS.—Insects which fly are, as a rule, provided with two kinds of eyes, simple and compound, of which the former are of use to them when at rest or when walking about, whilst the latter give them distinct vision when in rapid flight. The simple eyes in the case of flies are generally three in number, and are set at different angles on an elevation upon the top of the head, but the compound eyes occupy a large space at the sides of the head, and, especially in those species which fly rapidly, are frequently extended so as nearly to meet in front. In Diopsis, however, the position of the compound eyes is very peculiar, being placed at the ends of rigid stalks, or horns, extending from either side of the head and sometimes as wide apart as the entire length of the insect itself. These stalks also bear the antennae which are short and three-jointed, placed near to the eyes, the terminal joint bearing a long hair which probably acts like the whiskers of a cat by informing the bearer when there is danger of contact with objects in their vicinity.

Our illustration (Figure 469) shows the insect complete, magnified six diameters, and represents *Diopsis apicalis*, from Natal, and the head and eyes more highly magnified after having been prepared for microscopic examination by treatment which has rendered them translucent, and enables the nerves to be well seen which convey the sensations to the brain from the eyes and antennae.

The reason for this curious arrangement has not been clearly explained, as but little is yet known of the life history or habits of these insects; but the native who captured the specimen from which our drawing is made hazarded the opinion that as *Diopsis* is usually found on blades of grass growing near the river, it is enabled in this way to see what is going on beyond the leaf!

R. T. L.

Figure 469.

Diopsis apicalis, from Natal. The complete insect × 6 diameters, and the head and eyes more highly magnified.

ORNITHOLOGY.

By Wilfred Mark Webb, F.L.S.

THE BRENT VALLEY BIRD SANCTUARY—AN EXPERIMENT IN BIRD PROTECTION.—As mentioned in the column last month the writer, in his capacity as Secretary of the Selborne Society, gave an account of the work which had been carried out during the past few years in the Brent Valley Bird Sanctuary to the Conference of Delegates of the Corresponding Societies of the British Association at Dundee. As the paper may be of interest to our ornithological readers, it is here printed:—

"The difficulties of administering the Wild Birds' Protection Act are well known; but it is possible for individuals and societies, with a little trouble, to do something towards preserving birds, and it is an experiment in this direction which I am going to describe.

"Some eight or nine years ago it was suggested at a Committee Meeting of the Brent Valley Branch of the Selborne Society that some steps might be taken to protect the Nightingales, which were known to nest in a wood of about nineteen acres lying between Ealing and Harrow, which comes within the boundary of the London postal district. A small sub-committee of three members, of whom I happened to be one, was appointed to make arrangements, if possible, for the wood to be watched in the nesting season.

"As a result, it became part of the duties of a farm-hand to attend to warn off bird-catchers and birds'-nesting boys. After a year, however, the Committee took over the wood, employed a watcher of their own, and kept up the hedges with their own hands. But though success was attained in other directions, the nightingales were not heard for several seasons; in fact, not until the appointment of the present keeper, who is engaged all the year round, and takes a particular interest in his work.

"I may say now that the wood is composed of oak trees with coppice below, chiefly consisting of hazels, though there are many other trees and shrubs represented, and these have grown to a considerable size in places that have not been regularly cut every so-many years.

"Among the common birds that build as a rule are the Song Thrush, Missel Thrush, Blackbird and Hedge Sparrow; but there are often special points of interest concerning even them with regard, for instance, to the material of the nest, its position, and variations of the eggs.

"As a rule, too, from the beginning there have been each year a Chiffchaff's nest and several Willow Warblers'. The Garden Warbler and Whitethroat always breed and so does the Lesser Whitethroat, while the Turtle Dove builds every year. We have only once followed the development of the young cuckoo, though the eggs were found in the wood before it was protected. We have had on one occasion a wild duck's nest; but the parent birds were most probably shot outside the confines of the wood.

"The Long-Tailed Tit at one time was common and it is almost the only bird that has not increased in numbers. The Wren is numerous and builds in the open or under cover in empty tins or old kettles which may or may not have been put up for the purpose. The Robin is another bird which has the habit of making its nest sometimes in natural and sometimes in artificial surroundings.

"It is noticeable, however, that with the exception of an occasional pair of Blue Tits, one of which nested in a hollow branch, none of the birds which commonly build in holes, except the two already-mentioned, were found to nest. This, no doubt, was owing to the fact that the oak trees in the wood are young and sound.

"At the beginning of one season, however, my boy took it into his head to make some rough nesting boxes with large openings and, that summer, nests were recorded of the Flycatcher, the Great Tit, and the Tree Sparrow. Then other boxes were made with various-sized openings, and of more careful construction. These succeeded marvellously well. Blue Tits and Coal Tits built, the Tree Sparrows and Great Tits increased in number and the Wrens and Robins made use of the boxes as well as of the tins and kettles. The Nuthatch made its appearance and has been a resident in the wood ever since. Experiments were also made in the way of open boxes for Flycatchers, while trays for Blackbirds and Thrushes, which were fastened to the trees, found favour with some birds, in spite of the almost unlimited possibilities for their building in the undergrowth. Some of the visitors, whom we admitted sparingly in those days, asked us to make nesting boxes for them. The reputation of these dwellings spread, and as we were only too anxious to retain the services of our custodian, we were glad to be able to keep him busy in the winter, and the profits on the boxes went towards the expenses of the wood. It soon became evident that improvements could be made in the nesting boxes. For gardens also it might be advisable to have something a little less artificial looking. The only boxes on the market made from natural logs, with which we were acquainted, were those designed by Baron von Berlepsch.

"To these we found several objections:

"(1) First of all they were manufactured in Germany.

"(2) The idea of making them harmonize with their surroundings was not carried through, because there was a piece of ordinary board screwed on to the top of the log.

"(3) The lid could not be lifted off at any time for the content to be examined, and considerable trouble had to be spent in unscrewing it in order to clean out the boxes at the end of the season.

"(4) The inside, which was cut out very carefully to imitate the hole bored by a Woodpecker, did not provide much room in the smaller sized boxes for large broods, and all the trouble was thrown away in the case of all those which were fastened low down on the trees for the smaller birds. I therefore spent some amount of time and trouble, with the help of a member who has a joinery works, in producing a kind of box suited to our requirements, and these have been very successful. We made very rigorous tests last year with which we were quite satisfied.

"We find, also, that the opening of the box at the top (instead of at the front) does not disturb the birds if they happen to be sitting. A great deal more pleasure is, therefore, given to those who put up the boxes. The eggs and young can also be seen more easily, and quite useful nature study observations can be made, in which case even the commonest birds are useful.

"We have not forgotten that birds like the Woodpecker and the Wryneck make no nest and if their eggs are to be kept together for hatching a flat-bottomed box is useless. The bottoms of all the boxes are slightly curved, but special cup-shaped bases are put into those which are fastened high in the trees. We make specially large openings for Robins and restrict the size where only birds useful to the gardener are to be encouraged. It is useful to bear in mind that the Common Sparrow and Starling seldom build low down.

"I might call attention to the fact that a small series of boxes is on view in the Zoölogical collection arranged at this meeting of the British Association by Section D (Zoölogy).

"In addition to the birds that nest, we have a number that always seem to be present, but whose eggs we have not found. The list includes three species of Woodpecker, and the Brown Owl, which up to the present has refused all the nesting sites put up for its benefit. The Barn Owl is often to be seen, as is the Golden-Crested Wren. The Nightjar has been present during three seasons, the Kingfisher is a common visitor, and Jays and Magpies occasionally appear.

"Snipe sometimes frequent the outskirts of the wood and, on one occasion, I found a dead Woodcock within its boundary. This bird my wife had apparently seen alive a few days previously. Recent records include the breeding of the Goldfinch, Redpoll, Marsh Tit and the Wryneck.

"It will be noted, however, that very few of these birds are really rare; but it is the object of the Committee to protect those which occur near London. In the Brent Valley, there are few crops grown that the birds are likely to damage; but in other localities it might have to be borne in mind, when doing similar work, that certain species should not be unduly encouraged or indeed given protection.

"It is practically impossible to describe all the pleasure that can be obtained from such a reserve. It is a source of interest all the year round, and the mammals, reptiles, insects, and other creatures should be taken into consideration. The mice are somewhat destructive to eggs, but the way in which they utilise old birds' nests is worthy of attention. The fungi may be mentioned and a bird reserve also becomes a sanctuary for flowering plants. Steps will be taken to form committees in other parts of the country, and I should be very pleased indeed to give any advice that I can to those who are thinking of protecting any definite areas in the way which has been outlined."

"BRITISH BIRDS." The October number of this Magazine contains, as usual, many interesting notes. Miss Turner contributes an article and photographs on the Bearded Tit, while the Rev. F. C. R. Jourdain discusses the known cases of hybrids between Black Game and the Pheasant. A clutch of white eggs of the Ringed Plover is recorded for Blakeney Point in Norfolk, and we have accounts of the attempted breeding of the Grey Wagtail in Surrey, as well as the probable nesting of the Pied Flycatcher in Moray. Another matter of interest is the case of a Stock Dove laying again, as the Common Pigeon sometimes does, while its young were still in the nest.

PHOTOGRAPHY.

By EDGAR SENIOR.

EXPOSURE TABLE FOR NOVEMBER.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and the lens aperture F.16.

Day of the Month	Condition of the Light.	Time of Day: 11 a.m. to 1 p.m.	Time of Day: 9 a.m. and 3 p.m.
Nov. 1st	Bright	22 sec.	3 sec.
,, ,,	Dull	44 ,,	6 ,,
Nov. 15th	Bright	25 sec.	46 sec.
,, ,,	Dull	5 ,,	93 ,,
Nov. 30th	Bright	3 sec.	75 sec.
,, ,,	Dull	6 ,,	1·5 ,,

Remarks.—If the subject be a general open landscape, take half the exposures given here.

PHOTO-MICROGRAPHY OF OPAQUE OBJECTS.—Of late, considerable attention has been given to studying the microscopical structure of metals and alloys (metallography), and in this work photography plays a very important part. The specimens, which may be either fractured surfaces or polished ones etched with some material suitable to show the desired structure, may, "if small," be held in position on a glass slip by means of plasticine. In any case, the objects, being opaque, require to be illuminated by means of reflected light. When using low powers, diffused daylight is probably the best to employ, as an even illumination without deep shadows should generally be aimed at. In this case a vertical camera is a great advantage, as good lighting can be more readily obtained by its use. When employing daylight the camera should be placed near a fair-sized window, in such a position that the light falls upon the object from above as well as from the side. With a little care and attention to details it will be found fairly easy to obtain good results in this way. This method, however, is only suitable for very low magnifications, and even then unless the light is very good the exposure is unduly prolonged.

For many objects a condenser may be employed but care must be taken to avoid too much glare. When using artificial light such as an oil lamp, the bulls-eye condenser will be found useful, and this, when used in conjunction with a parabolic reflector will be found to illuminate opaque objects beautifully. Methods of this kind, however, can only be made use of with low powers such as twenty-four millimetre or sixteen millimetre objectives, as with lenses of a shorter focus than this, the working distance is too close for the light to reach the object. In this case some form of vertical illuminator, an appliance for passing the light through the objective becomes necessary. In its simplest form this consists of a thin circular disc of glass contained in a short mount which is attached to the lower end of microscope and into which the objective is screwed. A beam of light directed upon an aperture in the side of the mount by means of a bulls-eye, falls upon the reflector, and is projected downwards through the objective, and thus illuminates the object. This illuminator being transparent allows the light reflected from the specimen to pass through it, and reach the eyepiece, by which the image is viewed, in the ordinary manner. Care has to be taken in the adjustments of the apparatus, in order to avoid any veil or mistiness being imparted to the image under observation.

Instead of the disc of glass a small prism may be used, when a beam of light directed upon the opening in the side of the mount falls upon the prism, and becomes totally reflected from the hypotenuse surface downwards through the half of objective which it covers, and reaching the object brilliantly illuminates it. Thus the image seen through the eyepiece is entirely produced by the uncovered half of objective. For either method of lighting, the object should be uncovered or in optical contact with the cover glass, and objectives of higher power than sixteen millimetres must be specially corrected for uncovered objects. When oil immersion lenses are employed the specimens may then be covered. In order to reduce reflections upon the lens surfaces as much as possible, the objectives should be mounted in a manner which allows the back lens to be as close as possible to the prism. With this form of illuminator there are usually supplied thin metal diaphragms which slide into slits cut in the body tube; their use is to cut off reflections which give rise to a hazy appearance in the image, and, being adjustable from right to left, the position in which the image is seen at its best must be found by experiment. It is also advisable to reduce the image of the source of light "by means of an iris diaphragm," so that it is not larger than the field of view of the objective. As a deal of care is necessary in the adjustment of the light in order to get the best effect, special microscopes have been designed for use in metallography. These instruments have an adjustment for raising and lowering the stage, and as a fine adjustment is provided as well, the whole of the focusing is performed by this means, thus avoiding any shifting of the light by movement of the tube of the microscope. Excellent results can, however, be got with an ordinary microscope, although more time is occupied in obtaining them, and in the illustration (Figure 470) we have an example showing a photomicrograph of the etched surface of some cast steel, in which an ordinary microscope was employed, and light from a paraffin oil lamp the source of illumination.

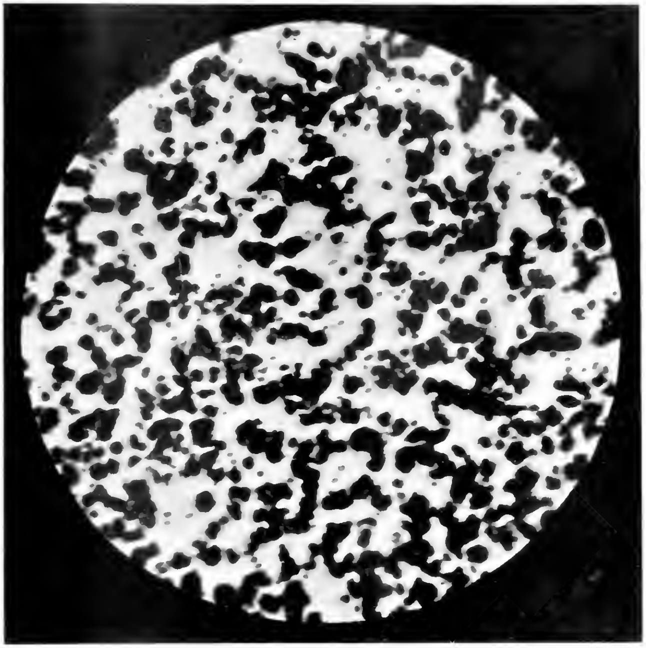


FIGURE 470.

Cast steel · 220 diameters. Photographed with an eight millimetre objective and Zeiss vertical illuminator, together with a four projection ocular.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

RESONANCE SPECTRA.—Professor Wood has continued his researches during the last summer on the resonance spectra of iodine vapour when it is excited by waves of light of different wave-length. His former work had showed that a very small difference in the wave-length of the exciting light caused a very great difference in the iodine spectrum; the latter differs when it is excited by the green line of the Cooper Hewitt mercury lamp made of glass from the spectrum obtained when excited by the same line from a similar lamp made of quartz but working at a higher temperature. It appeared that the exciting line might be broad enough to act upon more than one absorption line. The spectrum of the light absorbed by iodine vapour is very complicated. Professor Wood has estimated the number of absorption lines at fifty thousand; seven distinct lines were visible within the green mercury line, the wave-lengths varying from 5460·966 to 5460·579. To be able to make these measurements of wave-length with such remarkable accuracy, Professor Wood has constructed a very powerful spectrograph and as befits his well-known ingenuity, he has made it in a somewhat novel manner. The large plane grating was mounted on a cast iron pillar outside the laboratory, the slit and photographic plate holder was fixed on another pier just inside; these piers consisted of jointed water mains, while a bevel gear taken from an old hand-drill served to rotate the grating. The lens was one of forty feet focus and threw the spectrum on to the plate. Rectangular tubes made of wood connected the different parts of the apparatus, but they were not rigidly joined up so as to prevent errors arising from vibrations set up by wind or other source. This spectrograph, though constructed in such a simple manner, is probably the most powerful in the world. One interesting result obtained with this instrument is that there appear to be many coincident lines in the absorption spectrum of iodine and of bromine its kin amongst the elements. This would suggest that possibly there exist in the two elements identical systems of electrons, which give rise to similar frequences in the two molecules.

ABSORPTION SPECTRA.—Much work has been done on the absorption spectra of organic compounds, similarity in the position of the maximum of absorption being taken as a clue to similarity of structure of the molecule. The origin of the colour of an organic substance is supposed to be due to certain groups within the molecule called chromophoric groups; the simpler substances containing the chromophoric group usually have absorption bands in the ultra-violet or violet, so that they are yellow in colour and as the molecule gets heavier, with the addition of other groups the positions of the absorption bands shift towards the red end of the spectrum, consequently the colour of the compound becomes redder and then purple and finally blue. The mutual attractions between the groups within the molecule cause alterations in the vibration of the chromophoric group which is responsible for the absorption of the light, and the colours do not usually quite go through the series of colours that should theoretically be yielded by the formation of substances containing the chromophoric group and of gradually increasing molecular weight. The mutual transformation of one form of a substance into another molecular form of the same substance, or tautomerism as it is called, is supposed by some to give rise to the colour of many organic substances. However, most of this work has been of a qualitative nature; the results have been recorded on photographic plates, and it is not possible from a variety of causes to judge accurately the intensity of the absorption from examination of the plates. Quantitative measurements have lately been made by means of different spectrophotometers. In one such instrument the upper and lower halves of the slit are illuminated by beams of light polarised at right angles to one another, and the relation of the intensities of the two beams is given by the equation, $\frac{I}{I_0} = \tan^2\theta$, where θ is the angle through which the analysing nicol is turned.

By means of an apparatus such as this, the extinction coefficients can be found for various wave-lengths of the light throughout the spectrum, and the curve of absorption can be accurately plotted. Houston and others have made investigations on the salts of many inorganic coloured substances, and have tested the influence of different substances in combination with the coloured metal molecules. Merton has tried the difference in the absorption spectra of pure uranous and uranyl salts in various solvents, and has found that solutions in different solvents give quite different absorption spectra; but the apparent gradual shift observed when one acid radicle is replaced by another in the same solvent can be explained by the superposition of the absorption curves of the two compounds. It appears that the solution of a substance in a solvent is attended by considerable influence of the solvent on the dissolved substance, such that the molecular vibrations of the latter are disturbed by the presence of the molecules of the former.

THE COUNTING OF α PARTICLES.—Professor Rutherford has improved his apparatus for counting the α particles from radioactive substances. The radioactive material was placed in an exhausted tube behind a mica disc with a hole in it, placed at the end of a testing vessel within which is an electrode, which is connected to an electrometer. A definite fraction of the α particles pass through the hole and ionise the air in the vessel, which is at low pressure; this ionisation magnifies their effect enormously and a throw of the electrometer needle results. The experiments have been carried out lately with improved apparatus—special devices for preventing the scattering of α particles on entering the vessel for counting the number of throws of the electrometer needle (even one thousand per minute can now be counted), each corresponding to the entrance of one α particle. It is now possible to detect the electrical effect of one α particle when it traverses a gas at such a low pressure that its range is only reduced by $\frac{1}{20}$ mm.! This is a remarkable experimental achievement, when the small mass of the α particle (which is the same as a positively charged helium atom) is considered!

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A.

A WHITE PORPOISE.—In Notes No. XXXIII from the Gatty Marine Laboratory, St. Andrews, Professor W. C. McIntosh reports the capture of a white porpoise in St. Andrews Bay. It was a young female thirty-four inches long, of a dull yellowish white all over like a Beluga. A faint longitudinal band occurred along the upper lateral region on each side, and there was a somewhat crescentic dark patch from in front of the eye to the angle of the mouth. The eyes had the normal pigment. It may be said that this interesting white form retained traces of embryonic hues.

LONGEVITY OF BIRDS.—Anecdotal statements as to the longevity of birds are as common as precise records are rare. L. Petit, Senior, communicated recently to the Zoölogical Society of France, a number of records that he was prepared to vouch for. We quote a few instances—a sparrow of eight, a black-headed gull of ten, a blackbird of eleven, a small cardinal of fourteen, and an Amazon parrakeet of twenty-five years.

MARSUPIAL AMPHIBIANS.—In describing a new species of *Nototrema* from Brazil, L. G. Andersson discusses the origin of the dorsal pouch in which the eggs develop. In the female examined there was no trace of an opening to the exterior, though a large empty pouch extended as far as the head. It seems likely that the opening to the pouch closes up after the young have escaped. Weinland, who first described the pouch of Nototrema, regarded it as due to an intucking of skin, the upper leaf of the infolded skin coalescing with the dorsal skin. Another view, supported by Brandes and Schoenichen, that the pouch is formed from the dorsal coalescence of two longitudinal lateral folds, is based on the study of *Nototrema pygmaeum*. In this case it is supposed that the median suture opens along its whole length when the young escape; that the pouch completely disappears, and that it is formed anew next season. But Andersson's new species *Nototrema fulvorufa*, had a large empty closed pouch. The author suggests that the pouch in *Nototrema pygmaeum* may correspond to a sort of porch or vestibule to the real pouch of his specimen. "The outer part of the pouch, the vestibulum, originates from two low lateral folds, which grow towards each other, and disappear again when the young ones leave the pouch."

GLACIER-FLEAS.—As a fine example of the exuberance of life in a most unpropitious place, we may refer to J. Vallot's account of the multitudes of "glacier-fleas" (*Desoria nivalis*) which he observed on the *mer de glace* at Chamonix between "*l'Angle*" and "*les Moulins*" (see *Comptes Rendus* CLV, 1912, pages 184–185). These "glacier-fleas," discovered by Desor, are minute and primitive wingless insects, belonging to the family of Podurids; but they are so rare that Vallot had never before seen them in his twenty-five years' experience of Mont Blanc. Yet there they were covering the small pools of water on the melting ice, ten of them on a square centimetre! They occurred over a stretch of glacier twenty metres broad by two thousand metres long, and there must have been forty millions of them. This illustrates the extraordinarily rapid multiplication of a very rare type, and the quality of insurgence which is so characteristic of life.

SELF-EVISCERATION IN A STARFISH.—The unpleasant word "self-evisceration," somewhat suggestive of Hari-kari, denotes an interesting propensity or infirmity which is very familiar in sea-cucumbers or Holothuroids. Mr. Nathaniel Colgan has observed a case of it in the crimson starfish *Cribella oculata* or *Henricia sanguinolenta*. The process began by the appearance of a small lump of caeca on the upper surface and near the tip of one of the arms. The extrusion went on until one pair of caeca was fully exposed. It occurs "not by a catastrophic rupture, but by a long-continued series of muscular efforts, all tending towards the same end." In two cases there was extrusion of gonads as well as caeca. Further experiments are necessary before it can be maintained that the "self-evisceration" is adaptive, for the specimens were kept in unnatural conditions. "Exposed as they were to strong light for considerable periods while barely covered with water, which from time to time became more or less foul as compared with their native element, the animals must necessarily have grown sickly, so that the long-drawn-out muscular efforts which finally effected the extrusion of the viscera may have been merely symptoms of the approaching death of the organism."

A ZOÖLOGICAL PUZZLE.—In Ordovician, Silurian, and Devonian strata there are curious coral-like masses, usually hemispherical or cake-like, which are known as Stromatoporoids. They were monographed by the late Professor Alleyne Nicholson, who regarded them as Hydrozoa. There has always been great doubt, however, as to their real position, chiefly because of the difficulty of deciphering their structure.

Within the last eighty-six years they have been regarded as as Foraminifera, calcareous, [illegible], Monaxonellid, and Hexactinellid Sponges, Hydroida, Hydrocorallinae, Alcyonarians, Anthozoan corals, Polyzoa, Cephalopoda, and vegetables! Mr. Kirkpatrick, of the British Museum, has now come to the conclusion that they are Foraminifera. A vertical section shows apparently a meshwork of regular or irregular radial and concentric calcareous strands, which are really the edges of walls of Foraminiferal chambers. It may be noted as an instance of the difficulty of the subject that Mr. Kirkpatrick [illegible] the Stromatoporoids Foraminifera in September and [illegible] Sponges in August. He returns to an old [illegible] that of *Eozoon canadense*, a reputed fossil from the Laurentian serpentine. Most zoologists have of late agreed to surrender *Eozoon* to the petrologists; but Kirkpatrick revives Carpenter's conclusion that it represents a genuine organism. He regards it as belonging to the Foraminifera, nearly related to Labechia and Beatricea.

SOLAR DISTURBANCES DURING SEPTEMBER, 1912.

By FRANK C. DENNETT.

SEPTEMBER contrasted strongly against August in the amount of solar activity observed. On five days only—1st to 3rd, 29th and 30th—was the disc recorded as free from disturbance, and on four others—4th, 5th, 22nd and 23rd—only faculae were noted. On the remaining twenty-one days spots were visible. The longitude of the central meridian at noon on September 1st, was 174° 59'.

No. 15.—A group of pores first seen on September the 6th, amid bright faculae just round the eastern limb. There was much variation in the grouping of the pores from day to day.

No. 19. A tiny pore on September 24th directly in front of a faculic disturbance close to the east limb. On the 25th, there was a little triangle of pores with a tiny point behind it. On the 26th the leader and the trailer had both enlarged, the former containing three umbrae. It had decreased on the 27th, and when last seen on the 28th only a tiny pore remained.

On September 22nd, Mr. Booth kept in view a tiny pore, approaching the central meridian, but distant about 15°, with a twelve-inch unsilvered glass Newtonian, using powers

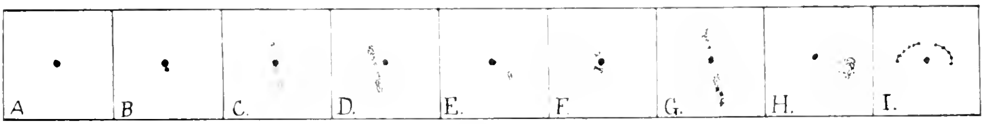


FIGURE 471.

The diagram figures it upon the 9th. On the 12th only a little gray pore marked the place of the leader. Its greatest length was 67,000 miles.

No. 16.—A pair of spots near the western limb, in a group of faculae only seen upon the 8th.

No. 17.—A considerable faculic area was visible a little way on to the disc from the east limb on September the 10th. On the 12th or 13th a small black spotlet appeared in this area with two pores just ahead of it. On the 14th it was a group 45,000 miles in length, and later increased to 60,000 miles. The spots attained their greater diameter on the 18th, when the region directly north-west of the largest middle umbra appeared of a light violet colour as seen with an unsilvered glass Newtonian reflector. It was last seen close to the western limb on the 21st.

No. 18.—A group of spotlets and pores broke out amid faculae nearing the western limb on the 14th, and was last seen next day.

varying between eighty and four hundred diameters. He estimated that from four to six of the minute granulations which go to make up the photosphere would have covered up the pore. His drawings are reproduced in Figure 471. A, at 9 a.m.; B, 10 to 10.30 a.m.; C, D, and E show dull fluctuating lanes amid the granulation; F, a bright lip on the western or preceding side of the pore; G, a dull lane containing veiled pores; H, a stationary veiled patch from 1 until 2.15 p.m.; and I shows the pore, at 4.20 p.m., set within curves of minute points joined by thin dark lines.

Faculic areas were recorded around longitude 62°, latitude 8° S. from September the 4th until the 7th; at 329°, 35° N., on the 21st, at 185°, 5° S. on the 23rd and 24th; and between the sites of groups numbered 16 and 19, on the 24th and 25th.

The chart is constructed from the joint observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, C. Frooms, D. Booth, and the writer.

DAY OF SEPTEMBER 1912.

C

REVIEWS.

BIOCHEMISTRY.

Oxidations and Reductions in the Animal Body. By H. D. DAKIN, D.Sc., F.I.C. 135 pages. 9¾-ins. × 6 ins.

(Longmans, Green & Co. Price 4s. net.)

This volume forms one of the excellent series of monographs on biochemistry now being issued under the general editorship of Drs. R. H. A. Plimmer and F. G. Hopkins. Biochemistry, though quite a young science, is a rapidly-growing one, and this series, therefore, supplies a very real need. A series of short monographs, moreover, has the advantage over a large text book covering the whole ground that it may more easily be kept up to-date, by revising volumes when necessary.

The present book gives a full account of the work that has already been done on oxidations and reductions in the animal body. As to the latter, not much seems to be known. Everyone is aware, however, that many compounds (e.g., carbohydrates) containing carbon and hydrogen are oxidised in the animal body to carbon-dioxide and water, thereby producing the heat necessary to life; but it is in very few cases that these simple compounds are produced immediately from the complex ones; more generally they result from long series of katabolic changes, and the study of the intermediate compounds produced is not only of interest and importance for the chemist, but also for the physician.

The course of oxidation in the animal body does not as a rule follow that obtained *in vitro* by the use of the ordinary laboratory oxidising agents, but it can generally be obtained *in vitro* by the use of hydrogen peroxide. It seems likely, therefore, that oxidations in the body are produced by means of unstable superoxides. Fatty acids undergo oxidation only in the β position, a truly remarkable change, which can only be produced *in vitro* by the aid of hydrogen peroxide. Knoop studied the fate in the body of fatty acids in which a resistant radical had been introduced, as otherwise complete oxidation generally results. He found that whilst benzoic and phenylacetic acids were unoxidised, phenylpropionic and phenylvaleric acids were converted to benzoic acid and phenylbutyric acid to phenylacetic acid (of course, the products obtained from the urine were combined with urea), and was thus led to the above generalisation. In support of this theory it may also be mentioned that only those fatty acids yield acetoacetic acid when perfused through a surviving liver which contain an even number of carbon atoms, showing that the acetoacetic acid results by continued oxidation in the β position.

The contents of the book have been admirably arranged, and its value is enhanced by the inclusion of a very complete bibliography. The only point we are inclined to criticise is that the diagram on page 66, showing the conversion of phenylalanine into acetoacetic acid in the body, is apt to give the impression that phenylacetic acid when perfused through a surviving liver as an intermediate product, which is not the case, since, as Dr. Dakin points out, phenylacetic acid, if administered, is excreted without oxidation as phenaceturic acid.

H. S. REDGROVE.

BIOLOGY.

The Mechanistic Conception of Life. Biological Essays.—By JACQUES LOEB, M.D., Ph.D., Sc.D. 232 pages. 58 figures. 8¼-in. × 5¼-in.

(The Cambridge University Press. Price 6/- net.)

This volume contains ten essays (reprinted from various sources) dealing for the most part with experimental biology. Interspersed, however, are occasional metaphysical speculations and criticisms of other metaphysical speculations; and the main object of the writer seems to be to illustrate and enforce the theory laid down in the essay which gives the title to the volume. The mechanistic conception of life which the author advances is that the sum of all life phenomena can be unequivocally explained in physico-chemical terms. But a complete scientific account of life must take account of all the relations involved therein, and, as Professor Lloyd Morgan has pointed out, there is absolutely no justification for excluding the conscious relation. And, however far it may be possible to explain all biological phenomena in terms of matter and motion (or inertia and energy)—and certainly physical science is justified in making the attempt—Huxley's objection still holds that we know matter and motion only as forms of consciousness, and hence, no explanation of consciousness is logically possible in terms of matter and motion. As a specimen of Dr. Loeb's metaphysics the following may be quoted—"Nobody doubts that the durable chemical elements are only the product of blind forces"—but does any metaphysician believe it?

The speculative portions of Dr. Loeb's essays (with their hypostatising of force, and confusion between a scientific account of phenomena aiming at co-ordination of relations and a metaphysical explanation of the source of phenomena) need not be taken very seriously. It is better to ignore all such speculations and pay attention only to the purely scientific portions of the book. These will be found full of interest and value by scientific men who are not sufficiently specialists in biology to wish to consult the original memoirs of Dr. Loeb's and other investigators' experiments. Dr. Loeb's experiments in artificial parthenogenesis are particularly important, and throw much light on the physico-chemical aspect of fertilization. It appears that, in the case of the eggs of the sea-urchin, and some other cases, two processes are necessary for fertilization. First, the cortex of the egg must be cytolized, to allow the formation of what is termed a fertilization membrane. This can be artificially brought about by means of butyric acid. The spermatozoon probably effects it by means of a lysin. The second process seems to be of a corrective nature. It can be brought about artificially either by placing the egg in hypertonic sea-water containing oxygen, or in isotonic sea-water free from oxygen (or containing a trace of potassium cyanide, which prevents oxidation), after which it is transferred to ordinary sea-water.

There are also interesting accounts of various tropisms, the heliotropism of the aphid being particularly remarkable. Indeed, in this respect the aphid behaves just like a machine, and Dr. Loeb's explanation, in terms of the action of light, through the optic nerve, upon one of a pair of symmetrical muscles, is probably correct. But it is well to remember that all the actions even of an aphid are not of the nature of tropisms.

H. S. REDGROVE.

Aristotle's Researches in Natural Science.—By THOMAS EAST LONES, M.A., LL.D. 274 pages. 10 illustrations. 8¾-in. × 5¾-in.

(West, Newman & Co. Price, 6/- net.)

The writer of this book has undertaken a useful and an interesting task. It is no other than to clear a road for the student of Aristotelian science by setting forth, in the order and style of a modern text-book, the main facts of Aristotle's scientific knowledge and teaching. While in some of Aristotle's philosophical treatises his style is in the highest degree polished and clear, this is not always the case in his writings, and it is certainly not so, for instance, in his History of Animals. This, and some of the other books, are full of repetitions and seem strangely disordered; so much so that critics sometimes speak of them as having come down to us in the form of mere lecture notes, never set in order for publication. Accordingly, with all the help that translations can give us, it is not easy to find out what Aristotle precisely said, or what he probably knew, regarding any particular thing; still more is it difficult to get a general view of the range of his scientific knowledge. Such an epitome as Dr. Lones now gives us is a great help to the student, and I think it will be welcomed by all naturalists and physicists who care for the historic aspect of their science. In such an epitome one loses much; one misses Aristotle's homely style of narrative and all the archaic terms of his phraseology, which even a translation does not let us wholly lose. There is a certain charm in the discursiveness of his style, in which one seems to trace how his mind caught up point after point, and where every here and there some great and original thought looms out amid the simpler narrative. But the epitome serves a good and even indispensable purpose of its own, and in this case it seems to have been made with skill and learning, and with loving sympathy for the work of the philosopher.

In an introductory chapter the writer gives us a brief and pleasant account of Aristotle's life, of his various writings and of the history of Aristotelianism. He reminds us, for instance, that the phrase "there is nothing new under the sun" was an old saying in Aristotle's day, and was a favourite of Aristotle's own. He sketches some of the many ideas, or some of the many words, that come to us direct from Aristotle; he shows us, for instance, that in such familiar words as form and habit, faculty and energy, essence and quintessence, we are using Aristotle's language; that diptera and coleoptera and selachia and cetacea are Aristotle's own words; that the physicist, the naturalist and the metaphysician are, *ipso nomine*, Aristotelians.

The book proceeds in the next place to give us an account of Aristotle's physical writings, such as are contained in his work on Meteorology and in his tract on the Heavens; and then, in greater part, it consists of an orderly account of Aristotle's Natural History, as gleaned from the various biological treatises. In the beginning of this latter portion of the book we find an account of Aristotle's discussion concerning the relation between animals, plants, and things inanimate, the various forms or grades of the "Vital principle": in short, the question of the passage from lifeless to living matter, which is to-day as open to discussion as ever, and can scarcely be discussed at all without reference to Aristotle's own terms and arguments. From the manner of composition of the elements, fire, water, earth and air, we are led on to the tissues and organs of the body, the description of which leads off into many interesting bye-ways of physiology and anatomy. And lastly, after brief chapters on animal locomotion and on generation and development, the book ends with an account of Aristotle's classification of animals—that is to say, of his knowledge of systematic zoölogy.

Dr. Lones' book is too close-packed to be easy reading: it does not set forth to be a contribution to Aristotelian criticism, and here and there there are minor points of interpretation with which we are not inclined to agree. But be all this as it may, the book is meant to be useful, and it seems to me to make good its claim to usefulness. It is plain that the writing of it has been a labour of love and the work of years.

D. W. T.

HORTICULTURE.

Present-day Gardening.—Chrysanthemums.—By THOMAS STEVENSON, with Chapters by C. HARMAN PAYNE and CHARLES E. SHEA. 112 pages. *The Rock Garden.*—By REGINALD FARRER. 118 pages. *Tulips.*—By THE REV. J. JACOB. 116 pages. Each with 8 coloured plates. 8½-in. × 6¼-in.

(T. C. & E. C. Jack. Price 1/6 net. each.)

The three books whose titles are given above belong to a series which is being edited by Mr. R. Hooper Pearson, the Managing Editor of *The Gardeners' Chronicle*. The special feature of these useful volumes is that they are all written by experts, and that they are each illustrated with eight coloured plates reproduced from photographs by Mr. T. Ernest Waltham. Very many of these are strikingly beautiful, and they are the best pictures of their kind that have been produced for the purpose, while, when it is noticed that the price of the books is only 1s. 6d. each, it will be obvious that all lovers of flowers are to be congratulated on having many of the best varieties put before them as they appear in flower in addition to just the kind of information they require. The pictures of chrysanthemums may be specially mentioned, though the views in "The Rock Garden" are not quite so pleasing as the individual plants, probably owing to their backgrounds, though they give a good idea of the appearance of forms illustrated. Fifteen of the books have appeared and a number of others are in preparation.

W. M. W.

MYCOLOGY.

Fungoid Diseases of Agricultural Plants.—By JAKOB ERIKSSON, Fil.Dr. 208 pages. 117 illustrations. 8¾-in. × 5½-in.

(Baillière, Tindall & Cox. Price 7/6 net.)

The name of Professor Eriksson is a sufficient guarantee for the excellence of this text-book on the diseases of plants caused by fungi. On turning to the account of the rust-fungi (Uredineae), on which Professor Eriksson has published so extensively, one naturally finds a statement of the author's "mycoplasm" theory. These fungi have a somewhat complex life history, in the course of which several different kinds of reproductive cells are produced in succession, and until about ten years ago it was generally supposed that the infection of plants in spring or early summer was invariably due to the germination of spores which had passed the winter in a resting state. According to Eriksson, however, this explanation is insufficient to account for the spread of certain rust-fungi, and he claims to have discovered that the fungus can and does exist in the cells of the "host" plant as "a formless plasma body, a sort of *plasmodium*, symbiotically fused with the protoplasm of the cells, and forming together with these a *mycoplasm*" (to quote from the present work). "The mycoplasm-carrying cell presents otherwise a normal appearance, with nucleus, chlorophyl bodies, and so forth. There cannot be recorded any parasitical fungoid life that would waste away the host plant. We may surmise that the fungus in this way can exist in most of the chlorophyll-carrying cells, up to the ears and bloom, in all sorts of seed that are specially suitable for the fungus, or, as it is expressed, are in a higher degree susceptible. The period during which the fungus exists in this latent state varies in different cases. From four to five weeks it might last for as many months and even for some years. This is the *dormant* stage of the mycoplasm. Sooner or later, at a certain period of the life of the host plant, at a certain season, and with favourable environment of circumstances (soil, moisture, warmth, light, and so forth) for the development of the fungus, and varying with different sorts of rust, there will commence a new stage in the existence of the mycoplasm—the stage of *maturing*, when the fungus forces its way out from the symbiotic complex, penetrates the walls of the cell, and develops an intercellular mycelium. This maturing seems to be of short duration: it lasts only for a day or two, or possibly only some hours. As soon as the intercellular mycelium begins to form, it takes generally one week before open rust sores with spore-stuff begin to appear on the surface of the plant." It is only necessary to add that this remarkable explanation has received very little support from other investigators, to say nothing of its inherent improbability on general grounds. One cannot blame an author of a text-book for giving prominence to his own theories, but in this case some of the evidence *against* the mycoplasm theory might have been added, if only in a foot-note, for the guidance of students.

It is a pity this English version of Eriksson's book was not read through by a competent botanist in this country before publication. Had this been done, the English rendering would doubtless have been more elegant if less clingingly exact in its fidelity to the original, and we should not have met such queer terms as "isotagious," "heterota[illegible]ous," and "parasitismus." There are numerous [illegible] illustrations, and a useful table of the fungoid diseases, arranged according to the host plants, is given in an appendix. The book is well got up, but seems rather expensive for its size.

F. C.

OCEANOGRAPHY.

Science of the Sea. Prepared by The Challenger Society. Edited by G. HERBERT FOWLER, B.A., Ph.D., F.L.S. 452 pages. 217 figures and 8 charts. 8-in. × 5½-in.

(John Murray. Price 6/- net.)

To those about to start on a long voyage who often ask how they can do some work for science, to yachtsmen, to naval officers who are apt to find time heavy on their hands in port or in a foreign station, this book has been addressed by the Challenger Society; for if they take up some of the subjects which are so admirably outlined in its pages they will enjoy an ever fresh interest in the sea, its workings and its inhabitants. It would not be easy to find any important matters which have been left out. The names of those who have contributed the various chapters are a guarantee that the information is sound and reliable. The air, water, shore, floating and fixed plants, floating animals and those of the sea floor are naturally considered; but we may turn from the hints as to dress and medicines, given by Professor Stanley Gardner, to the interesting dissertation on the sea serpent by Professor D'Arcy Thompson. Yacht equipment, methods of dredging and trawling, and the preservation of marine organisms are all considered. The Editor gives some excellent advice as to notes and labels, and the material of which note-books should be made. The names of marine stations throughout the world should prove most useful for reference, as should also the chapter on literature; while the classified list of firms who will supply equipments, nets, apparatus and chemicals, though it might be amplified very considerably in some directions, has the advantage of containing only the names of those who are recommended from personal knowledge by the authors.

W. M. W.

PSYCHOLOGY.

An Introduction to Psychology.—By WILHELM WUNDT. Translated from the Second German Edition by RUDOLF PINTNER. 198 pages. 7½-in. × 5-in.

(George Allen & Co. Price 3/6.)

Students of the science of psychology will welcome this brief expression of the long and patient researches of the veteran Leipsic Professor. It starts on the basis of experiment, and it goes no further beyond this basis than is legitimate in any scientific enquiry. To give a bare summary of its contents would be to do the author and our readers little service. We should advise all who are interested in the modern development of the subject, and in the manner in which the essentials take form in the mind of a great master, to read it and then to read it again. They must not expect to find this an easy matter. Notwithstanding lucidity of treatment, which is admirable and seldom fails in its aim, the concepts themselves are such as to demand close and prolonged attention. And Professor Wundt is not the man to slur over or sneak round difficulties, which are inherent in a subject so complex as that which deals with the constitution of the human mind. The principle on which he would lay the chief stress is that of "creative resultants." "It attempts to state the fact that in all psychical combinations the product is not a mere sum of the separate elements that compose such combinations, but that it represents a new creation." In logical phraseology there is always somewhat more in the conclusion than is contained in the premises. We believe that he is right in his emphasis on this principle. But if he regards it, as may be inferred from his mode of statement, as characteristic only of *psychical* combinations, we believe that he is mistaken. We regard this as true of *all* combinations which come under the comprehensive heading, "Evolution." His insistence on the importance of the principle is, however, in any case wise; and it is part of a work which is characterised by its wisdom.

C. LL. M.

The Composition of Matter and the Evolution of Mind. By DUNCAN TAYLOR. 176 pages. 7½-in. × 5-in.

(The Walter Scott Publishing Co. Price 3/6.)

To deal fully with this book in the columns of "KNOWLEDGE," would be a difficult task. We feel relieved from the duty of attempting it because this is not a journal of metaphysics. We use the term metaphysics in no disparaging sense; we employ it in contradistinction to science. By science we understand an enquiry into the phenomena of nature, taking the word nature in its widest sense, and into the concepts which are of value for the interpretation of these phenomena. By metaphysics we understand an enquiry into the ultra-phenomenal source (often called the cause) of nature and our knowledge thereof. That enquiry is beyond the limits of science which is content to accept the constitution of nature as something given, and to formulate the results of its enquiry in terms of correlation. It leaves all questions with regard to the source of origin of this constitution to metaphysics. Mr. Taylor urges that "The Omniscient Spirit of the omnipotent, inexhaustible Central Power holds and attracts all being by the means of the seminal interfusion of spiritual initiative, the positive element, in its atmosphere ether." He is very earnest in the expression of his views and uses freely the terminology of science. But it is quite impossible to discuss them here. It must suffice to have given a slight and necessarily inadequate indication of their scope.

C. LL. M.

TOPOGRAPHY.

British Association, Dundee Meeting, 1912.—By A. W. PATON, F.I.P.S., and A. H. MILLAR, LL.D., F.S.A. 683 pages. Illustrated. 7½-in. × 5-in.

(David Winter & Son.)

It is customary for a handbook to be issued at each meeting of the British Association dealing with the place in which its annual gathering is held. The one produced by the Publications Committee at Dundee will be hard to beat, and not only has it proved of particular interest to the visitors, but it must be of permanent value to the residents and to the city. It deals with Dundee as it was, as it is, and as it may be; with its social problems; with its hospitals, and philanthropic institutions; with its public services, parks, slaughter-houses, water supply, museums and art galleries. The city is considered as an educational centre. There are no less than eighteen chapters on the subject of its present-day industries; nor are its ancient trades forgotten. Biographies of a number of its worthies are given. The scientific part occupies itself with geology and with the local flora, in connection with which coloured botanical surveys and geological maps are inserted in pockets in the covers of the book. There are special chapters on fossil fishes, mosses, birds, and the evolution of the race in Forfar, and perhaps only in the omission of local lists of other biological divisions will the handbook compare unfavourably in the minds of some with its predecessors. The seven hundred pages are rounded off with a consideration of art, the drama and music in Dundee. The Publications Committee is to be sincerely congratulated upon the result of its work, and in conclusion we quote the opening words of the "Welcome" with which the book begins: "We worship at the shrine where knowledge lifts a venerable head."

W. M. W.

ZOÖLOGY.

The Individual in the Animal Kingdom.—By J. S. HUXLEY. 167 pages. 14 illustrations. 6½-in. × 5-in.

(Cambridge University Press. Price 1/- net.)

Whether we agree or not with the author's conclusions set forth in this little book, its perusal leaves three distinct impressions. First, that he is no mere armchair philosopher who has "dabbled" in biology, but a practical zoölogist with firsthand knowledge of what he writes about. Secondly, that he is a man of marked literary taste and ability, and thirdly, that he has thought for himself on a philosophical subject that has keenly interested biologists since the days of the "Naturphilosophen."

Mr. Huxley in his preface disarms criticism, for he points out that his facts are true whether or no we agree with him as to the particular meaning which he attaches to the philosophical use of the word "individual," and it is to a most interesting series of facts that he draws attention. The book is so written that the educated layman will have little difficulty in following the train of argument if he takes it seriously, while the zoölogist will doubtless learn new facts, the results of research recently published, that have not yet found their way into the textbooks. Dogiel's discovery of a new group of simple parasites, the Catenata, Woodruff's work on *Paramoecium*, and Newman and Paterson's remarkable account of Armadillo quadruplets, will assuredly be new to many who, like the present writer, strive in vain to keep themselves *au courant* with discoveries in zoology, amidst a rush of professional work.

The first chapter will probably be found least easy to follow; but it must be grappled with if the author's point of view is to be understood. The remaining ones are all more or less easy reading. The illustrations call for no comment; but we could wish that less use had been made of footnotes. It only remains to be said that the book should have a wide sale, and the author must be congratulated on the interesting and stimulating manner in which he has put forth his conclusions on some important points.

SATURN.

By FRANK C. DENNETT.

Of all celestial objects Saturn stands alone as an example of exquisite beauty. As an object for continuous study many other bodies doubtless are of greater interest, either from lower instrumental powers being of greater service, or from constant physical happenings bringing continual change. But as an object of beauty Saturn is unrivalled. The ball, some seventy-five thousand miles in diameter, is marked, even more regularly than Jupiter, with belts parallel with its equator. Some of these are easily observable with a telescope so small as two and a quarter inches in aperture. But to see the whole, with the exquisite colours they display, will tax the powers of the best instruments under the most favourable conditions. The form of the globe is best seen when the rings are presented edgeways. Apparently then one of the poles is flattened rather more than the other.

The ring system is the cause of the exceeding beauty. It may well have puzzled the first observers with their inferior instruments. Nowadays, seeing that we have some knowledge of the nature of the object, even a two-inch achromatic will give a pretty view, when the rings are widely open as they are now. Every increase of aperture, however, adds to the beauty. A two and a half inch to three inch reveals the fact that the ring is divided into at least two parts, an outer ring and an inner. This was first discovered in 1675 by Cassini, hence the division is often known as Cassini's. It was at one time called Ball's through a mistaken interpretation of the writings of one of the brothers Ball. It will be seen that the inner ring is brightest and fades inwards, also that the outer ring is not evenly bright. A little increase of aperture reveals the presence of the inner "crape veil," the semi-transparent ring discovered simultaneously in England and America by Dawes and Bond respectively, in 1850. That it was in existence previously there can be no doubt, because Cassini shows its form where it crosses the planet so far back as 1715. Yet the Herschels and Schroeter with their giant reflectors, and Struve with the 9·6 inch Dorpat achromatic repeatedly studied the planet and missed it. In 1880 it could not have well been overlooked even with a four and a half inch reflector.

The ring system presents many problems. In the first place, the ball is not exactly in the middle of the rings, but just a little to the west of the centre. This has been noted even with quite small instruments. The Cassini division, too, is not always equally dark. The outer ring has a division in it known as Encke's, from his careful measures of its position. The peculiarity of this division is that on equally propitious nights, and with the same instrument, the division is variable. Sometimes it may be seen hard and sharp in one ansa, whilst no trace of it can be found in the other. Sometimes the best instruments fail to reveal it, whilst at others it is like a mere pencil marking. Further, it is not a fixture, sometimes appearing nearer the inner edge, at others nearer the outer. Occasionally it has appeared to be accompanied by other still finer divisions. The middle ring usually seems simply to fade inwards, but sometimes appears to be sensibly stepped, and it has been observed apparently divided by at least three narrow divisions. The inner dusky ring looks at times as if in contact with its neighbour, at others, separated from it by a division, whilst occasionally the "crape veil" has itself seemed to be split by a division.

Another mystery of the rings is that the outline of the planet's shadow upon the rings has appeared not smooth, but notched. The best explanation of this is to be found by supposing that the rings are either not all of the same thickness, or else—or perhaps also—that they are not all in the same plane. This last suggestion is seemingly borne out by the fact that at the last time when the rings were presented edgeways they never quite disappeared even with a three-inch achromatic, whilst with larger instruments they appeared as bright knobs or beads.

Were the ring-system solid it would not be stable as the outer portions would be travelling at a much greater rate than the inner. This would inevitably lead to disruption: the inner portions travelling too slowly would be drawn downward upon the planet, whilst outer parts travelling too rapidly would rush off—away from the planet's control. Keeler's spectroscope proved that the rings were not solid; that the inner portions were travelling, in accordance with necessity, much faster than the outer portions. The consequence of this is that there is a constant change of the particles with respect to each other. This explains the irregular density observed at the extremities of the curves from time to time as seen with the largest instruments, and the variations in the divisions. At present, November, 1912, Saturn is in good position for observation, high up in the heavens between the Pleiades and Aldebaran. Moreover, the rings are at such an angle that the northern pole is hidden behind the rings, whilst the southern one is apparently bedded on them. Although Saturn is not so brilliant as Jupiter, it is a remarkable fact that the same telescope can be used with higher powers on the former than upon the latter with good result. The five older known moons may be observed with any telescope of about four inches in diameter; but they are not so interesting as those of Jupiter, as their phenomena are not so easily observed. Dual discovery was again shown when Lassell, in England, and Bond, in America, simultaneously found the tiny Hyperion in 1848. This satellite, like the oldest known, Rhea, Dione, Titan, and Iapetus, displays variations in its brightness in different parts of its orbit, variations which seem to indicate that, like our Moon and some of Jupiter's, they always present the same face to their primary.

THE FACE OF THE SKY FOR DECEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.		R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 46.

Date.	P	B	L	P	P	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 47.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN moves South till December 22nd, reaching the Solstice at $5^h m$ on that day. Sunrise during December changes from 7 44 to 8 8; sunset from 3 53 to 3–58. Its semi-diameter increases from 16′ 15″ to 16′ 18″. Nearest Earth 1913, January 1st.

MERCURY is an evening star till December 8th, then a morning star. At greatest elongation 22°·4 W. December 28th. Illumination, December 1st one fifth. December 8th zero, December 31st seven-tenths.

VENUS is an evening Star, approaching its greatest elongation. Illumination three-quarters, semi-diameter $7\frac{1}{2}''$.

THE MOON.—Last Quarter 1^d 11^h $5^m m$; New 8^d 5^h $7^m e$; First Quarter 16^d 8^h $6^m e$; Full 24^d 4^h $30^m m$; Last Quarter 30^d 8^h $12^m e$. Apogee 14^d $7^h m$, semi-diameter 14′ 47″; Perigee 26^d $3^h m$, semi-diameter 16′ 32″. Maximum Librations, December 6^d 5 W., 10^d 7 N., 20^d 7 E., 24^d 6 S. January 1^d 6 W. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1912.			h. m.		h. m.	
Dec. 2	σ Leonis	4·2			0 44 *m*	314
" 3	BD −0 2554	7·0			3 18 *m*	207
" 12	BAC 7128	6·3	4 10 *e*	49	5 25 *e*	258
" 17	44 Piscium	6·0	6 1 *e*	340	6 20 *e*	302
" 20	19 Arietis	5·8	3 12 *m*	59		
" 20	30 Arietis	6·5	3 37 *e*	110	4 12 *e*	185
" 20	40 Arietis	6·0	6 0 *e*	135	6 17 *e*	163
" 21	BD +22 545	7·0	6 45 *e*	71		—
" 21	BAC 1170	5·5	8 7 *e*	71	9 20 *e*	242
" 22	30 Tauri	5·0	4 21 *m*	143	4 49 *m*	202
" 23	BAC 1848	5·0	6 57 *e*	16	7 17 *e*	323
" 23	136 Tauri	4·0	7 31 *e*	124	8 17 *e*	217
" 25	47 Geminorum	5·0	0 30 *m*	138	1 33 *m*	243
" 25	BAC 2383	6·5	3 11 *m*	112	4 15 *m*	279
" 26	BD +24 1603	7·0			2 11 *m*	353
" 26	χ Cancri	5·0	2 10 *m*	59	3 0 *m*	346
" 26	BD +21 1960	7·7		—	7 55 *e*	322
" 28	37 Leonis	5·5	0 40 *m*	87	1 45 *m*	333
" 30	BAC 4143	6·5	0 11 *m*	128	1 11 *m*	204

TABLE 48. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

MARS is a morning Star, but practically invisible.

JUPITER is invisible, being in conjunction with the Sun on December 18th.

SATURN was in opposition November 23rd. Polar semi-diameter 9½″. The major axis of the ring is 47⅓″, the minor axis 19½″. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). December $1^d\ 11^h{\cdot}5$ *e*, $9^d\ 0^h{\cdot}7$ *e*, $17^d\ 1^h{\cdot}8$ *m*, $24^d\ 3^h{\cdot}0$ *e*. Dione (every third given). December $1^d\ 3^h{\cdot}7$ *e*, $9^d\ 8^h{\cdot}6$ *e*, $18^d\ 1^h{\cdot}6$ *m*, $26^d\ 6^h{\cdot}6$ *m*.

METEOR SHOWERS (from Mr. Denning's List):

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Nov. 25 to Dec. 12	180	73	Rather swift.
Dec. 4 ...	162	+ 58	Swift, streaks.
,, 6 ..	80	+ 23	Slow, bright.
,, 8	145	+ 7	Swift, streaks.
,, 8	208	+ 71	Rather swift.
,, 10—12	108	+ 33	Swift, short.
,, 12	119	+ 29	Rather swift.
,, 22	194	+ 67	Swift, streaks.
,, 21—22	117	+ 47	Swift.
,, 31 ..	92	+ 57	Slow, bright.

The shower Dec. 10—12 is a conspicuous one.

Rhea (every second given). December $4^d\ 9^h{\cdot}9$ *e*, $13^d\ 10^h{\cdot}6$ *e*, $22^d\ 11^h{\cdot}2$ *e*, $31^d\ 12^h{\cdot}0$ *e*.

For Titan and Iapetus, E. W. mean East and West elongations, I., S. Inferior and Superior Conjunction, Inferior being to the North, Superior to the South. Titan, $2^d\ 0^h{\cdot}7$ *m* I., $5^d\ 8^h{\cdot}6$ *e* W., $9^d\ 6^h{\cdot}9$ *e* S., $13^d\ 9^h{\cdot}6$ *e* I., $17^d\ 10^h{\cdot}1$ *e* I., $21^d\ 6^h{\cdot}2$ *e* W., $25^d\ 4^h{\cdot}6$ *e* S., $29^d\ 7^h{\cdot}5$ *e* E. Iapetus $2^d\ 11^h{\cdot}8$ *e* I., $21^d\ 11^h{\cdot}3$ *e* W.

URANUS is an evening Star, semi-diameter 2″. It is 7½° South of Alpha Capricorni, 5° South-West of Beta. It is 1½° North of Venus on the 14th.

NEPTUNE is a morning star, approaching opposition.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
H III. 25	3^h 8^m	N 47 ·0	Faint cluster.
H I. 60	3 22	S 21 ·7	Nebula.
H I. 107	3 30	S 18 ·9	Nebula.
Pleiades	3 39	N 23 ·5	Well known cluster. Photography shows many nebulae.
H IV. 53	3 59	N 60 ·6	Planetary nebula.
H VII. 61	4 7	N 51 ·0	Bright cluster.
H IV. 26	4 10	S 12 ·9	Planetary nebula.
B. 64	4 55	S 14 ·9	Remarkable red variable star.

DOUBLE STARS.—The limits of R.A. are 3^h to 5^h.

Star.	Right Ascension.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
	h. m.					
52 Arietis ...	3 1	N 25 ·0	6, 6	95°	½	Bluish-white.
	A tenth magnitude star at 350°, 5″.					
7 Tauri ...	3 29	N 24 ·2	6½, 6½	180	¼	White, yellow.
	A tenth magnitude star at 60°, 22″.					
W.B. (2) III. 657 S ...	3 34	N 34 ·0	7, 7	60	2½	White.
o Persei ...	3 39	N 32 ·0	4, 8	237	10	White, ash.
Piazzi III. 100 ...	3 55	N 80 ·5	5, 6	69	1	Yellow, blue.
ξ Persei ...	3 48	N 31 ·7	3, 9	206	13	Yellow, blue.
32 Eridani ...	3 50	S 3 ·2	4, 6	349	6	Yellow, purple.
ε Persei ...	3 52	N 39 ·8	3, 8	8	9	Greenish, blue.
Σ 484 ...	4 0	N 62 ·0	6, 6	303	18	Whitish-yellow.
	In cluster H VII 47.					
o^2 Eridani ...	4 11	S 7 ·7	4, 9	40	2	Yellow, blue.
	Period about 170 years. A star distant 82″ also belongs to the system.					
1 Camelopardi ...	4 25	N 53 ·8	5, 6	306	10	Bluish-white.
2 Camelopardi ...	4 33	N 53 ·4	5, 7	288	1½	Yellowish, bluish.
	There is also a very close companion, distant one-fifth of a second.					
Lalande 8603 ...	4 33	N 26 ·8	6½, 6½	202	3½	White.
7 Camelopardi ...	4 50	N 53 ·6	4½, 8	323	1½	Yellowish, white.
ω Aurigae ...	4 53	N 37 ·8	5, 8	354	6	Greenish, bluish.

TABLE 49.

CORRESPONDENCE.

WASTE IN COOKING.

To the Editors of "KNOWLEDGE."

SIRS,—In the very interesting article appearing in the current number of "KNOWLEDGE" under the title of "On Cooked Foods" the following sentence occurs:—

"With regard to meat it is stated that however cooked it loses from one-fifth to one-third of its weight."

It may interest your readers to know that meat may be cooked in electric ovens in such a manner that the loss is not more than from one-twentieth to one-eighth of its weight, or in other words from five to fourteen per cent.

To obtain these results it is, of course, necessary that the cook shall understand the proper use of an electric oven; but this is easily learnt.

The extraordinary difference in shrinkage between meat cooked in an electric oven and meat cooked in any other way, seems to be due partly to the fact that electric ovens being practically airtight very little evaporation takes place, and partly to the evenness of electrically generated heat. There are probably other reasons which though not apparent to a cook, would at once occur to a scientific mind.

If any of your readers could explain the matter from a scientific point of view it would be extremely interesting, and it seems to me that the whole subject is one which in the interests of economy cannot be too widely ventilated.

AMY CROSS,
First Class Diplomee National Training
School of Cookery.

NOTICES.

INSTRUCTION IN PHOTOGRAPHY. We have pleasure in announcing that Mr. Senior, our photographic editor, is [illegible] on photography at the Central Young Men's Christian Association, Tottenham Court Road, in [illegible].

FIRST AID. We have received a well illustrated little booklet, dealing with [illegible] Airmen and their Equipments, from Messrs. Burroughs, Wellcome & Company, which also contains some useful notes on first aid.

FABRE'S WORKS. Messrs. Hodder & Stoughton announce that they will publish this autumn the first volume of the collected works of J. H. Fabre, the eminent French naturalist, which will be issued under the title of "The Life of the Spider."

ZOOLOGICAL LITERATURE. We have received from Mr. Felix L. Dames, of Steglitz, Berlin, his one hundred and twenty fifth catalogue of Zoological Works—two thousand five hundred odd in number. They are classified under various useful headings, and among them are many books and papers which are not often seen in second hand lists.

SECOND HAND APPARATUS. From Mr. C. Baker comes a classified list of second hand instruments, which is issued three times a year. As on previous occasions, we commend its seventy-four pages to those who need good microscopes, lenses, and other apparatus of first-class quality, at reasonable prices.

We have received as well Messrs. Clarke & Page's second-hand list, which should also be consulted.

THE TAIT MEMORIAL.—The committee appointed to suggest the form which the memorial to Professor Tait should take recommends the raising of a fund of from £20,000 to £25,000 for the purpose of endowing a second Professorship in Natural Philosophy in the University of Edinburgh. Pamphlets dealing with Professor Tait and his work, as well as the need for the Professorship, have been issued, together with the names of the general committee, who appeal for subscriptions to be sent to the honorary treasurer, Sir George M. Paul, 16, St. Andrew's Square, Edinburgh.

SELBORNE CENTRAL LECTURES. The Selborne Society has arranged the following central lectures for the coming session:

1912

Nov. 11. "Fairy Flies and their Hosts."
FRED ENOCK, F.L.S., F.E.S.

" 25. "The Elizabethan Playhouses of London."
WILLIAM MARTIN, M.A., LL.D., F.S.A.

Dec. [illegible] "English Cathedrals" (Second Series).
CHARLES E. KEYSER, M.A., F.S.A.

1913

Jan. [illegible] Special Children's Lecture on "Dew, Hoar Frost and Cloud." SPENCER FLETCHER, F.R.A.S.

" [illegible] "On Minor Planets."
A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Feb. [illegible] "Fibres and Fibre Lore."
C. AINSWORTH MITCHELL, B.A., F.I.C.

Mar. [illegible] "Byways of Biology."
JAMES SAUNDERS, A.L.S.

The lectures will be given in the Theatre of the Civil Service Commission, Burlington Gardens, New Bond Street, at 6.30 p.m., except Mr. Enock's, which will be at 6.45, and the Children's Lecture, which will take place on a Thursday, at a time to be announced. Members may personally introduce one friend. Tickets to Members, price 6d. each; to Non-Members, 1s.

"THE "THIRD HAND" THUMB MAGNIFIER. Our readers may remember that we described and illustrated in our microscopical column an ingenious contrivance called the "Focostat," which consisted of a lens fastened on to one's [illegible] needle or pen. The "Third Hand" magnifier is a [illegible] lens, which by means of a clip, as its name implies, can be attached to the thumb, and it will prove extremely useful where the hand to which it is fastened need not be

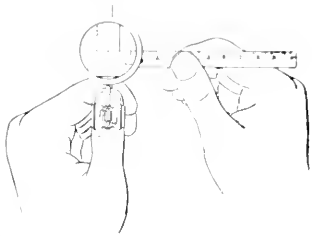


FIGURE 472. The "Third Hand" Thumb Magnifier.

moved. The magnifier is well adapted for reading fine scales (see Figure 472), and even for domestic purposes, such as the threading of needles. It has been brought out by "Third Hands" Patents, Limited, of City Road.

THE MUNICIPAL MUSEUM, HULL. On Wednesday evening, the 16th October, a new gallery was opened at the Municipal Museum, Hull, which is to be entirely devoted to the illustration of local mammals. The specimens include several historical examples from the collection of the late Sir Henry Boynton, and other sources, and some of them are the last records of the kind for the district. The collection is arranged in specially-made cases, in which the animals are shown in their natural surroundings, in addition to which there are several large groups showing male, female and young of Otters, Badgers, Hedgehogs, Deer, Foxes, and so on. On the occasion mentioned the curator, Mr. T. Sheppard, gave an address on the Mammals of the East Riding of Yorkshire.

FORGED EGYPTIAN ANTIQUITIES.—Within recent years a great demand has arisen for relics of Ancient Egypt, and large sums of money are spent by the public each year in the purchase of scarabs, pottery, figures, and so on, which are said to have been taken from the tombs in that country. Many of these objects are frauds, and of quite recent manufacture, but as the itinerant sellers have a most plausible manner and a glib tongue, travellers are frequently taken in, and pay large sums of money for worthless specimens. It is with the object of giving some guidance to those interested in Egypt and its antiquities that Messrs. A. & C. Black are publishing a book, by Dr. T. G. Wakeling, entitled, "Forged Egyptian Antiquities," which will be illustrated with many examples of objects usually offered for sale.

HORNIMAN MUSEUM LECTURES. — We have received a list of the ten free public lectures which will be given in the Lecture Hall, Horniman Museum, Forest Hill, at 3.30 p.m., on Saturday afternoons. We print the titles of those which still remain to be given at the time of going to press:

Nov. 2. "The Botany of Bread."
MISS E. M. DELF, B.A.

" 9. "Money before Coins." MR. A. R. WRIGHT, F.R.A.I.

" 16. "Animal Parasites and their Life Histories."
DR. W. A. CUNNINGTON, M.A.

" 23. "A Folk-lore Tour in Brittany."
MR. EDWARD LOVETT.

" 30. "The Origin and History of Dogs."
MR. H. N. MILLIGAN, F.Z.S.

Dec. 7. "Shoes and Sandals of the Past."
MR. A. R. WRIGHT, F.R.A.I.

" 14. "Women's Work in Central Africa."
DR. W. A. CUNNINGTON, M.A.

Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

DECEMBER, 1912.

THE EVOLUTION OF THE CUCKOO.

By G. W. BULMAN, M.A., B.Sc.

THOSE who hold the theory of natural selection, looking back in time, see the Cuckoo as a bird with the normal instincts of its kind. Darwin was persuaded that even to-day it still sometimes shows traces of those ancestral instincts. "It has also recently been ascertained," he wrote, "on sufficient evidence, by Adolf Müller, that the Cuckoo occasionally lays her eggs on the bare ground, sits on them, and feeds her young." How, then, in the struggle for existence did it attain its present strange and unique position among the birds of our country? That instinct which leads it to hand over the care of its eggs and young to foster-parents is doubtless a *great advantage* from the Cuckoo's point of view. There results for it a life of ease, no troublesome nest-building, no trying work of brooding over eggs, no voracious young to be fed at the expense of much time and trouble. The Cuckoo is free to speed off for Africa's sunny shores early in July, while other birds are still toiling over their broods. For the individual cuckoo the advantages are obvious; its life becomes a "primrose path of dalliance." The advantages to the race, however, are not so obvious. It is not clear that the Cuckoo leaves a more numerous and stronger progeny than it would if it reared its brood in the usual way, or than it did while it was still respectable. This, of course, is mere speculation, but the fact remains that the Cuckoo is not specially numerous in this country. It is less so than many birds which rear their young in the ordinary way. But, waiving this doubt as to the possible ultimate advantage of the habit, let us go back to the commonplace respectable Cuckoo, or Cuckoo-like bird building its nest and hatching and rearing its own young. Some abnormal twist in the brain of a certain Cuckoo led it to pick up one of its eggs and place it in the nest of a Titlark. We will suppose it thus disposed of *all* its eggs, though we are not quite sure that the etiquette of natural selection would not bind us down to *one* in the first instance. Let us suppose that this brood is more successfully reared than those treated in the ordinary way. This might arise from the fact that the Cuckoos were careless nurses—though this is not a quality that could be evolved by natural selection. Or an adult Cuckoo may have been unable to feed a full brood as well as a Titlark could feed a single young Cuckoo. But, however it may have arisen, let us assume the advantage to have been with the Cuckoo which got its young reared by the Titlark. The quality or instinct which led the female Cuckoo to act thus would probably appear in *some* of the descendants, the rest inheriting normal instincts from paternal sources. But in the descendants of those which did inherit the new instinct, this would run a heavy risk of being swamped by intercrossing with others of normal instincts. This, however, is a very common difficulty in the case of an incipient new species, and we will suppose the new instinct managed to survive the flood. It might then be reinforced by the sporadic appearance of the like in other individuals. Those possessing the instinct would leave more numerous and stronger progeny, and those which did not adopt it would be finally weeded out by natural selection. Thus the Cuckoo race sauntered down a curious bypath of evolution to the idle life.

But if this be accepted as the general outline of the evolution of the Cuckoo there are also certain special points which call for attention. There are, for example, the strange instincts and actions of the young Cuckoo in the nest. In the Cuckoo's respectable days it cannot have been the little demon it now is. It cannot have been in the habit of turning its brothers and sisters and eggs out of the nest. So it probably had not then the convenient hollow in its back for holding the eggs. And yet these habits, instincts and structure seem absolutely essential to the well-being of the young Cuckoo. Only by turning everything else out of the nest can it obtain sufficient nourishment for itself. And yet the first Cuckoo hatched in a Titlark's nest cannot be supposed to have had these characters. It would get no advantage in the strange nest, and would probably be starved.

The eggs of the Cuckoo have suggested another evolutionary problem. More than a hundred years ago, the naturalist Salerne gave currency to the idea that the egg of the Cuckoo resembles those beside which it is placed. He was himself hardly a believer in the assertion, but gave it on the authority of an inhabitant of Sologne. In 1853, Dr. Baldamus brought forward the same idea, and supported it by a series of eggs in his cabinet. But English ornithologists were slow to accept this view. They saw, for example, that in the case of the Hedge Sparrow, in whose nest the Cuckoo so frequently places its eggs, there was no resemblance at all. On the basis of the collection of Cuckoos' eggs in the Natural History Museum Sir Wm. Flower gives the following summing up of the question:

"We have now a fine series of Cuckoos' eggs, with those of the birds in whose nests they were laid, showing in many cases a great resemblance in colour, in others none at all. In some Hedge Sparrows' nests the Cuckoos' eggs are as blue as the others; but in some they are of the more usual speckled-brown. It has been doubted whether the blue eggs were really those of the Cuckoo, but Mr. Seebohm set the question at rest by taking an undoubted young Cuckoo (with its very different feet from the Sparrow's) from one of them. The Cuckoos' eggs vary much in colour, and, generally speaking (though with many exceptions), show some conformity to the eggs of the bird in whose nest they are laid."

Professor Newton was inclined to accept the theory of the resemblance with the reservation that there are "numerous instances in which not the least similarity can be traced." Granted the resemblance, then, it is an obvious suggestion that its object is the more successfully to deceive the foster-parents. And this being so it admits of an explanation on the lines of natural selection, since those Cuckoos which most successfully palmed off their eggs on their dupes would succeed best in the struggle for existence. Thus the Cuckoo which laid a robin-like egg and placed it in a Robin's nest would succeed better than one whose egg had no resemblance to those of its host. And having once confided its egg to a Robin, a Cuckoo would be likely to continue doing so, and the daughters would be likely to inherit the habit. Thus there would be a tendency to produce separate races of Cuckoos, one laying blue eggs in Hedge Sparrows' nests, another blue brown-speckled eggs in Robins' nests and so on. It is easy to suggest objections to this explanation. In the first place it is not obvious that any deception is necessary. As a rule birds seem ready to sit on any sort of eggs. Our domestic hen will hatch ducks, turkeys or pheasants as readily as her own chicks; in Sir John Sinclair's classical attempt to introduce the nightingale into Scotland the eggs of this bird were hatched by Robins; the Hon. Daines Barrington reared linnets under Skylarks, Woodlarks and Titlarks; Starlings have been known to sit on and hatch bantams' eggs. Professor Newton, however, suggested that while some species of birds are thus easily deceived there may be others which are not. And it would be only in the nests of the latter that we should expect to find the Cuckoos' eggs approximating closely to the others. This would explain the numerous exceptions. But to test the view thoroughly we should require to have figures showing the relative frequency of the resemblance in the case of a number of different species of small birds. There is some evidence that the Reed Warbler is one of the objectors, but in the one case in which we have seen—in a museum—a Cuckoo's egg in the nest of this bird it was *very different* in size and markings. We suggest, however, that those Cuckoos which habitually placed their eggs in the nests of the easily deceived Robin and Hedge Sparrow would succeed so much better in the struggle for life than those which went with their not yet perfectly matching eggs to the nests of the more fastidious birds, that the latter would, according to the principles of natural selection, be weeded out.

Let us suppose, however, that the Cuckoo species is divided into races laying eggs of different colours, blue, dark grey speckled, blue speckled with brown, and so on. Should we not expect this race segregation as regards eggs would be accompanied by some differences in plumage and other characters? In the case of the domestic fowl we know that differences in the eggs are associated with variations in other characters. No case of two varieties laying different eggs without variation in plumage, and so on, can be brought forward. But no such racial differences can be pointed out in the Cuckoo.

And then we must remember that the male Cuckoo has his part to play in the matter. Is there any evidence that a male hatched in a Wagtail's nest, for example, usually seeks for its mate a female laying Wagtail-like eggs, or reasons why it should? What marks are there by which he could recognise the right female, supposing his tastes were orthodox? And if he did not choose the right partner would not the variation in the direction of laying Wagtail-Cuckoo eggs be swamped? Nay, further, might it not happen that if a Hedge-Sparrow-Cuckoo mated with a male hatched from a Robin-Cuckoo egg, the blue-egg layers among the offspring would inherit the instinct of placing their eggs in Robins' nests, and those which laid eggs like the Robin's the instinct of choosing the Hedge Sparrow as foster-parent?

And then must we not also consider the question of the evolution of what we may call the receptivity in the foster-parent? Professor Newton points out that this *varies* in different species, and thus it becomes a quality subject to the action of natural selection. In the beginning, again, it must have been variable among individuals of the same species. Some would receive the Cuckoos' eggs, and some would reject them. The latter would succeed best in rearing their own offspring, while those which reared young Cuckoos would leave no inheritors of their—from the Cuckoo's point of view—virtues. Thus the quality of receptivity could never be evolved on the lines of natural selection: those possessing it would be weeded out.

The evolution of the Cuckoo by natural selection, in fact, bristles with difficulties.

PREHISTORIC HEARTHS ON THE COAST OF SOUTH WALES.

By ARTHUR L. LEACH, F.G.S.

In 1906 Messrs T. C. Cantrill and O. T. Jones, of the Geological Survey, in drawing attention[*] to certain heaps of burnt stones, which they had discovered chiefly in the inland parts of Pembrokeshire and Carmarthenshire, suggested that they were the sites of prehistoric—probably Neolithic—cooking-places, and that the stones had been used as "pot-boilers" in some primitive mode of cookery. Since that date many more have been detected by various observers, and in a recent paper by the same authors, on "Prehistoric Cooking-places in South Wales" (*Archaeologia Cambrensis*, June, 1911), two hundred and seventy-one hearths are enumerated, and their probable age and origin are more fully discussed. With the exception of a group of three such hearths upon the Pembrokeshire coast described[†] by me (see Figure 473) and included in the above list, none of the recorded examples are situated immediately on the coast-line. During the month of August, 1911, I noted three additional hearths near the shore: they present, particularly in one case, as will be seen, some features of unusual interest which may help to throw light on the problem of the age of these curious mounds of burnt stones.

From a photograph by R. H. Chandler.

FIGURE 473. Hearth above the shore at Swanlake, Pembrokeshire.

in which a flint flake was found amongst the burnt stones. The photograph shews also the channel of a small stream immediately beside the hearth.

In the chalk districts of south-eastern England the burnt flints, which occur commonly on the North and South Downs in the vicinity of prehistoric settlements, are known familiarly as "pot-boilers" and easily may be recognised by the innumerable tiny cracks forming a close network on their calcined surfaces. These cracks are due to repeated expansion and rapid contraction of the stone when it was used as a "pot-boiler" by being first heated strongly and then dropped into a cooking-pot containing water. "Pot-boilers" may be found scattered over the ground in some localities in association with flint cores and flakes, while not infrequently small cooking-pits or fireplaces are discovered filled with broken pottery, fragments of bones, charcoal and calcined flints. The Welsh mounds of burnt stones present some features of peculiar interest and, unlike the Downland cooking-places, which sometimes may be definitely assigned to the Neolithic or to the Bronze age, the period of their use remains still a matter of speculation.

In outward appearance a hearth is usually a low mound, overgrown by grass or gorse, situated close beside a spring or small stream, and rising but little above the general level of the ground. It may be quite irregular in outline or roughly circular and from six feet to fifty feet in diameter; occasionally it assumes a crescentic or horseshoe form with the concavity towards the stream. On digging into the mound (or observing

From a photograph by R. H. Chandler.

FIGURE 474. Hearth at Marros, Carmarthenshire.

The burnt stones are overlapped on each side and almost covered by the storm-beach pebbles which have been thrown up since the occupation of the cooking place.

[*] "Note on the Discovery of Prehistoric Hearths in South Wales." *Arch. Camb.*, 1906, page 17.

[†] "Note on the Discovery of Prehistoric Hearths at Swanlake." *Arch. Camb.*, 1909, page 243.

the section caused by the partial destruction of the coast line hearths by the sea it is found to consist of a layer, not more than three or four feet thick and frequently much less, of very angular stones packed in dark soil mixed with much charcoal and charcoal dust. The stones, rarely larger than pieces broken for road metal, are burnt black, yellow or bright brick red in colour, and obviously are fragments of larger blocks of sandstone, quartzite or other hard rocks which have split up after frequent heating and sudden cooling. Many of the mounds have been almost destroyed under the plough, others are mere lines of "pot-boilers," while others still contain several tons of burnt stones.

Of the six hearths found by me near the shore, the three at Swanlake and one described below, are all good examples and quite typical, but the last is of more than ordinary interest.

The hearth at Marros (see Figures 474, 476, and 477) lies twenty-five yards from an excellent spring which issues about twenty or twenty-five feet above the shore. A streamlet trickles past the hearth and now oozes away below the storm-beach which, since the occupation of the cooking-place, has been banked fully twenty feet above the shore by winter storms and has not only blocked the course of the little stream but has almost completely buried the mound. On the seaward side, however, where a recent storm has torn away a large segment of the hearth, a clear section is exposed down to the underlying yellow drift clay. The true hearth consists of a layer three feet thick of rather small angular pieces of sandstone, grit, and quartzite, (all from the local rocks), burnt and discoloured by fire and closely packed in dusty charcoal. It is noteworthy that none of the burnt stones seem to be fragments of beach pebbles, although the whole mound is now surrounded and covered by such pebbles. A quite exceptional feature appears on the seaward side where there is a row, six feet long, of large blocks of sandstone: this may be a remnant of a low retaining wall.

Of relics, which might throw light on the period when this cooking place was used, it may be said, in the words of Dr. Johnson, that "the negative catalogue is very copious," for no traces of pottery or other cooking vessels, bones, shells, stone or other implements, could be found. The remark is equally true (with two possible exceptions) of all the hearths yet examined but very few have yet been carefully searched.

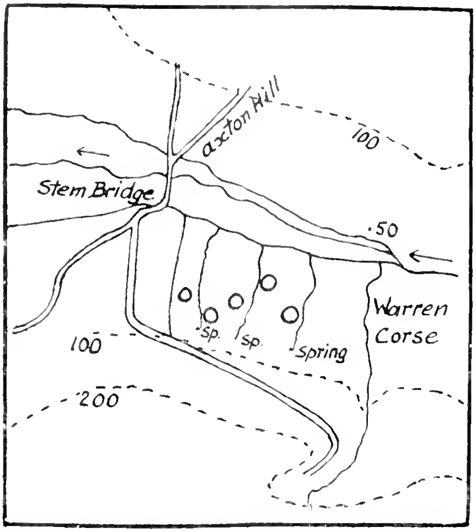


FIGURE 475. A group of five hearths (indicated by the small circles) on Warren Corse, near Castlemartin, Pembrokeshire.

The exceptions are at Swanlake, where from each of two of the hearths I obtained a flint flake amongst the burnt stones and charcoal. No other clues to the age of the hearths have as yet been found actually in any of them, but Messrs. Cantrill and Jones picked up several flakes on a mound broken up by the plough, and they record the occurrence of flakes and a core near a spring adjoining a hearth at Westhook. During the year 1911 I found flint flakes and cores in the vicinity of other hearths:

(1) Near the spring at Marros.

(2) In rainwash near a hearth at Manorbier.

(3) In rainwash near a hearth at Cwm Mawr, Newgale.

(4) In rainwash, three feet deep, a few yards from the hearths at Swanlake.

(5) On a hearth on Warren Corse.

FIGURE 476. Diagrammatic section of a prehistoric cooking place at Marros, Carmarthenshire.
(d) Yellow stony clay. (s) Storm beach.

It is not probable that in all these instances the association between the hearths and the flint flakes is accidental; least of all at Swanlake, where flakes occur not only (1) in the hearths and (2) in rainwash very close to them, but also (3) on a chipping-floor on the cliff-top above the hearths. It seems fair to infer here a connection between the cooking-places and the presumably Neolithic chipping-floor.

Usually the mounds occur singly; but a few groups of two or three have been noted. The largest number yet observed in close association is a group of five in Warren Corse (see Figure 475), four miles south-west of Pembroke. From Axton Hill large black patches were observed on the bright red soil of a newly-ploughed field, and on investigation these proved to be typical hearths, situated immediately beside the streamlets (see Figure 475). A flint scraper of a peculiar steep-nosed form was picked up amidst the burnt stones disturbed by the plough.

To summarize the salient features of these hearths:—

(1) They are situated almost invariably beside springs or streams.

(2) They consist entirely of burnt stones.

(3) They have yielded neither pottery, bones, shells, nor any implements of metal.

(4) In two, possibly three, cases, flint chips have been found in them, and in several instances flint cores and flakes have been obtained in their vicinity, deeply buried in an old rainwash deposit.

The evidence, therefore, points to their use at an early date by people unacquainted with metals: that is, to some part of the Neolithic age.

This view receives support from the relation of these coastal hearths to the present shore line. At Swanlake the low cliff upon which they stand is gradually receding and large segments of the mounds have been destroyed by the sea; at Marros an enormous accumulation of pebbles has been built by the waves; yet, although the cooking-place is almost buried by these pebbles, not one seems to have been used as a "pot-boiler." It is clear that these hearths were in use before the coast-line had assumed its present form and while the land extended considerably further on what is now their seaward side. At a date so recent, possibly, as the Neolithic Age much of the shoreward part of Carmarthen Bay was a marshy woodland, connected with the fringe of land which has been traced by its "submerged forest" round most of the English and Welsh coasts. On the shore below the hearth at Marros the stumps of many large trees remain *in situ*, rooted in the stony clay which underlies the beach. The storm-beach has accumulated since the submergence of these trees and since the construction of the hearth. It seems probable that the prehistoric cooking-place was occupied while the ancient woodland grew between it and the sea. Such evidence as can be gathered from the hearths and their surroundings certainly favours their association with a period not later than the Neolithic age.

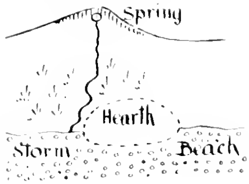


FIGURE 477.
Diagrammatic plan of the prehistoric cooking place at Marros, of which a section is given (Figure 476).

The particular method of cooking employed by the hearth-builders needs explanation. By modern studies of semi-civilised races various methods of boiling, baking, roasting, and grilling have been observed; down to the present day some Australian aborigines cook meat upon hot stones or ashes or upon a rough grill made of crossed sticks, or boil it in a bark trough or in a large shell by using "pot-boilers." In other cases the food is boiled or baked in small pits, made watertight by a lining of clay or skins. Some of these methods were probably in use in prehistoric Britain before skill had been attained in the manufacture of good fire-resisting pottery. In Ireland, heaps of burnt stones situated near springs have long been regarded as prehistoric cooking places, and in one case, cited by Messrs. Cantrell and Jones, there was found immediately beside the mound and level with the stream a wooden trough in which the food was probably cooked, the water being heated by "pot-boilers," which were used over and over again until they fell to pieces and fresh stones were selected. A mass of burnt stones and charcoal thus accumulated upon the hearth beside the cooking-trough.

That the South Wales mounds were cooking-places appears beyond reasonable doubt, and some of them were probably associated with cooking-troughs or hollows, but no traces of actual cooking-vessels have yet been found, and it may be that some of them were used chiefly for simpler methods of roasting or grilling by hot stones.

THE ROYAL INSTITUTION.

GENERAL MEETING.—A General Meeting of the Members of the Royal Institution was held on the afternoon of November 4th, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. Dr. J. H. McBride and Miss Jane Worth were elected members.

The Honorary Secretary reported the decease of Professor Henri Poincaré, an Honorary Member of the Institution, and a resolution of condolence with the family was passed.

CHRISTMAS LECTURES FOR CHILDREN.—We have been asked to announce that the eighty-seventh Christmas Course of Juvenile Lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Professor Sir James Dewar, LL.D., D.Sc., Ph.D., F.R.S., Fullerian Professor of Chemistry, his title being "Christmas Lecture Epilogues." The Lectures will be experimentally illustrated, and the subjects are as follows: Alchemy, Saturday, December 28th, 1912; Atoms, December 31st; Light, January 2nd, 1913; Clouds, January 4th; Meteorites, January 7th; Frozen Worlds, January 9th.

The Royal Institution is in Albermarle Street, and the lectures will be given at 3 o'clock in the afternoon.

NOTES ON THE ESSENTIAL OILS, INCLUDING AN ACCOUNT OF THE MATERIALS AND METHODS OF PERFUMERY.

By H. E. SLACK, Pharmacist.

The subject matter embraced by the above title covers one of the most extensive fields of modern industrial organic chemistry, and therefore it has not been attempted in this article to give more than a rudimentary outline of the numerous branches and processes involved, each of which is individually of sufficient importance and magnitude to merit the dedication of an entire volume.

It has been endeavoured, however, to give a brief resumé of the modes of preparation; the composition, and examination of the volatile oils; to name and describe certain animal and artificial substances employed in the manufacture of perfumes, and to conclude with a short survey of the methods adopted in manipulating to the best advantage numerous natural and synthetic products used for producing the exquisite and subtle combinations of odours possessed by many of our modern spirituous essences.

Bearing in mind that the spices and aromatics have been from time immemorial, and are at present, a prominent factor in the world's commerce, it may not seem out of place to commence with a brief retrospect of the history of the essential oils, which may be, for practical purposes, broadly defined as oily, odoriferous bodies, volatile without decomposition, obtained from vegetable sources.

In this, as in most researches into ancient historic documents, investigation as to the source and distribution of these materials leads to Central Asia, where the spices found use not only on account of their agreeable odour and taste, but also as articles of exchange, and in religious and sacrificial ceremonies.

Whether a beginning of the preparation of the aromatic principles of plants, our modern volatile oils, was made previous to early Hindoo or Egyptian civilization, does not become apparent, even from the oldest documents; but we know that the Egyptians, whose history dates back as far as 1000 B.C., were acquainted with common metals, furnaces and distilling apparatus.

The study of natural sciences was carried on to some extent by the Greeks and Romans, the insight gained by the latter people into the character of drugs being demonstrated by the writings of Dioscorides, Pliny and Galen. A decided advance in scientific research was achieved by the Arabs, who fostered the process of distillation already described by Synesios and Zosimos, two Greek scholars of the fourth century. The decay of Arabian science was brought about, however, by their ardent desire to convert the baser metals into gold, and it was not until the advent of Paracelsus, who taught that the object of chemistry was to make remedies and not gold, that a marked development of the art of distillation and a clearer conception of the nature and composition of the essential oils were acquired.

Information as to the subsequent progress of the oil-distilling industry is available in the form of several lists of current drugs and spices in the city of Frankfort-on-the-Main, which were published during the years 1450, 1580 and 1587, and in a book entitled the "Destillirbuch," written by Brunschwig and published during the sixteenth century.

Although in the year 1730 about one hundred and twenty volatile oils were known and placed in general use and commerce, it was during the eighteenth century that a great stimulus to the art of perfumery was initiated by the successful combination of several odours in attempts to produce agreeably fragrant mixtures. An example of such a preparation is afforded by the Eau-de-Cologne of Johann Maria Farina, introduced in the year 1725, which, in its modified form, is in great demand at the present time. The consequent greatly increased production of the oils, and constant growth of the industry in the South of France, caused more attention to be devoted to the constitution of the valuable primary odoriferous bodies which are applied in the perfumery art. Classical researches in this direction were conducted in Germany and France, but, as a record of these would be of a purely chemical nature, we will apply ourselves to a study of the isolation of the volatile oils, and incidentally, by the aid of a few diagrams, endeavour to trace the evolution of the modern steam distillation apparatus from the almost inconceivable crudities tolerated in the appliances used by the ancients and during the Middle Ages. The primitive distillation vessels employed in the production of the essential oils are described as open kettles heated by a direct fire, and having, as a condenser, a layer of wool supported by pieces of wood placed across the opening (Figure 478).

The form of subsequent stills appears to have been based upon the outline of certain animals; for instance, the goose provided an idea for a retort, as illustrated by Figure 479.

A further step was then taken by employing the advantages of the water and sand baths to replace the discovered deficiencies of the naked fire previously used, and by adopting various methods of condensing, by means of air and water—the vapours evolved during the distillation.

An inefficient type of air condenser, used as early as the fifteenth century and known as the "Rosenhut," is depicted in Figure 480.

The use of water as a cooling agent now came to have general application, and simultaneously sprang up the idea of the "Worm" condenser, one of the earliest forms of which is illustrated by Figure 482. The barrel was filled with cold water, which effected the cooling of the vapours as they passed through the undulating pipe. Special varieties of stills came into use for the manipulation of large quantities of materials; one of the most frequently employed and interesting of these, fitted up in the "galley furnace" style, is seen in Figure 481. These early processes, consisting of introducing the plant along with water into the apparatus, usually heated by a direct fire, display two disadvantages. Firstly, the plant itself may be easily burnt, with the result that the oil acquires a disagreeable empyreumatic odour, and secondly, a very careful adjustment of the amount of water is necessary, seeing that too little renders the oil-containing material more liable to be scorched, while an excess results in partial solution of the small amount of the distilled oil collected along with the relatively large volume of condensed water in the receiver.

Figure 478.
A primitive Condenser made of a layer of wool.

Figure 479.
An early form of Still based on the outline of a bird.

This latter dilute aqueous solution of the oil represents a considerable loss, as it can only be employed as an aromatic water.

To obviate these disadvantages, the simplest modification consists in suspending the plant substance in copper cages, which do not touch the bottom of the still.

Figure 480.
The "Rosenhut" air Condenser.

Water is run in, and when sufficient heat is applied, the steam produced by the boiling water carries over with it the essential oil. This process constitutes the basis of the English method (see Figure 483), and as several of the oils produced in this country are the finest obtainable, the (modified) method must necessarily be a good one.

In general, however, the process of steam distillation possesses many advantages, and constitutes the means employed in the large modern German and French stills, capable of holding eight thousand to sixteen thousand gallons. The *modus operandi* is as follows:—

The charge of material in a suitable state of comminution is placed upon a perforated false bottom; steam, which is admitted under pressure from a pipe coiled beneath the plants, carries over the essential oil through an outlet at the top of the still, into efficient condensers. A spiral of steam pipes lines the interior of the plant-containing portion, and the whole mass of material is continually turned over by means of mechanical stirrers. The mixture of oil and water in the receiver separates; the oil, having a specific gravity lower than that of the water, floats on the surface of the latter liquid, and is removed by suitable means.

The phenomenon of the high boiling oil distilling with the steam finds explanation in the fact that the atmospheric pressure, acting upon the mixture, is naturally divided between the steam and the other substances, so that the partial pressure upon the latter is accordingly less than the atmospheric pressure. In consequence, the volatility is increased. The distillation with steam is, therefore, to be regarded as a special case of distillation in a partial vacuum.

Two different types of steam distillation apparatus are shown in Figures 483 and 484. Figure 483 indicates the variety usually employed in this country for manipulating small quantities of material, the plants being placed in the upper globular portion, while the steam is generated in the lower reservoir. Figure 484 illustrates a great still of fifty thousand gallons capacity, used in the largest and most up-to-date essential oil distillery in the world, that of Messrs. Schimmel & Co., Miltitz bei Leipsig. To this firm I offer my heartiest thanks for their courtesy in allowing me to reproduce from "Die Aetherischen Öle" (Gildemeister & Hoffmann) Figure 484 as well as 485, which depicts a room in their distillery. Although the majority of essential oils are obtained by a process of distillation, great attention has to be paid to the properties of the oils, and to their individual constituents, in deciding what treatment is most advantageous. It is not possible here to do more than briefly refer to the other methods of isolation, which may be grouped under two headings, *viz.*: Expression and Extraction.

Of the many and various operations employed and involved in conducting the former, the Sponge or Spunga method is the one most generally used, being particularly adapted to obtaining the oils of the Citrus family, e.g., orange, lemon, and bergamot.

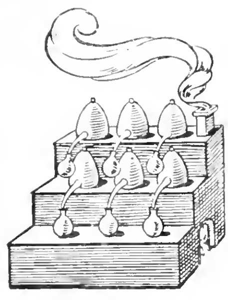


Figure 481.
A Still of the "Galley Furnace" type.

The pieces of the peel of

these fruits into pressed against a sponge, which breaks the oil vesicles and absorbs the liquid, the latter being periodically squeezed out. This is the process largely made use of in Sicily for obtaining oil of lemon, and the expressed oil, so obtained, is purified by filtration.

The second method "extraction" consists in removing the oil contained in the particular material by means of a solvent (chloroform, carbon bisulphide, methyl chloride, and so on), which, being usually volatile, is afterwards recovered by distillation, the remaining oil being freed from the resinous and colouring matter, also dissolved by the above-mentioned liquids, either by rectification under reduced pressure or distillation in steam. A further method of removing the odorous constituents of plants is performed by treatment with a non-volatile substance (lard or other fat); this method will be referred to later when we come to consider the preparation of perfumes. The distribution of essential oil in plants may be either general or local, the pine affording an example of the former, while in the rose it is confined to the leaves of the flower, in the cinnamon to the bark, and in the orange to the pericarp of the fruit.

The volatile oils, which in many cases are katabolically-produced secretion or excretion products, are found either in closed cells, or in special reservoirs in the plant tissues. The origin of the latter oil ducts or vessels may be either lysigenous or schizogenous, these botanical terms expressing respectively the absorption or separation of series of cells to form more or less definite cavities or passages. Figure 487 illustrates a lysigenous cavity in the pericarp of the orange, with a drop of ethereal oil, and Figure 486 a schizogenously-formed oleo-resin duct of a species of *Pinus*, with its layer of thin-walled parenchymatous epithelial cells.

In the hop the oil is found in dermal glands of capitate and peltate form, while in the Umbelliferae it is stored in tube-like structures, known as vittae,

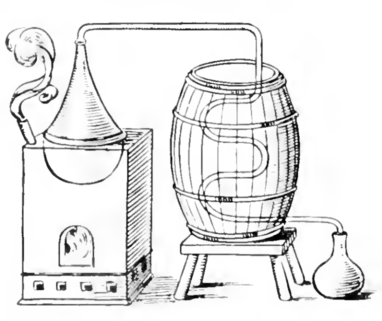


FIGURE 482.—An early form of the worm Condenser.

chiefly in the fruits, the latter usually possessing two such vessels on the commisural and four on the other surface of each mericarp, although in the anise many more (usually twenty to thirty) vittae are discernable in either half of the cremocarp.

Although most essential oils pre-exist in the plant tissues, many owe their formation to the hydrolysis of substances of a glucosidal nature, brought about by ferments.

Examples of this chemical action are afforded by the production of the volatile oils of black mustard (seed) and bitter almond (seed). In the former the enzyme is a substance called myrosin, while the glucoside is represented by sinigrin; in the latter emulsin and amygdalin illustrate the same classes of

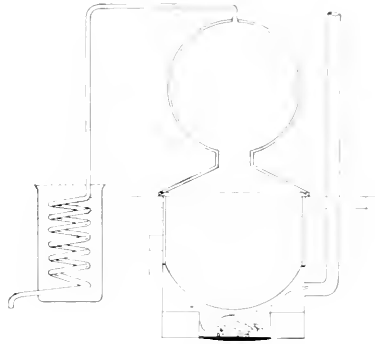


FIGURE 483. Steam distillation apparatus used in England for small quantities.

substances. No action takes place in the seeds of these plants on account of their active principles being situated in different cells; but when these cells are ruptured in the presence of water the reactions indicated by the following equations occur:—

$C_{10}H_{16}KNS_2O_9 + H_2O = C_3H_5CSN + C_6H_{12}O_6 + KHSO_4$
Sinigrin — Allyl Isothiocyanate + Glucose + Potassium Hydrogen Sulphate

$C_{20}H_{27}NO_{11} + 2H_2O = 2C_6H_{12}O_6 + C_6H_5 \cdot CHO + HCN$
Amygdalin — Benzaldehyde + Hydrocyanic Acid.

In the latter case the poisonous hydrocyanic acid has to be removed by suitable treatment before the oil is safe for use as a flavouring agent, when it will consist of practically pure benzaldehyde. When the oils of black mustard and bitter almond are manufactured in large quantities, the seeds are first subjected to a process of maceration with water, to allow the formation of characteristic odorous principles, indicated in the above equations.

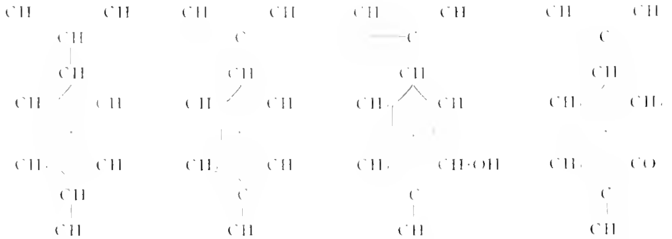
We will now divert our attention from the production to a very brief review of the more common constituents of the essential oils.

These may be roughly classified under the following heads: (1) The Terpenes, (2) Alcohols and esters, (3) Phenols and their derivatives, and (4) Aldehydes and ketones.

It is proposed to outline the main properties of these great groups of organic compounds, and to illustrate, by the aid of Table 50, their occurrence in a few well-known volatile oils.

(1) The hydrocarbons, known as the terpenes, along with their derivatives, constitute the most

widely distributed compounds found in the essential oils, and form the subject of extended scientific research. The hydrocarbons possess the general molecular formula $C_{10}H_{16}$, and are often accompanied in nature by other unsaturated ones of higher molecular weight, having the same empirical formula, C_5H_8. Those expressed by $C_{15}H_{24}$ have been named sesquiterpenes, whilst the more complex ones still have been termed polyterpenes $(C_5H_8)_n$. Although the constitution of the terpenes has not been definitely ascertained, they are known to be derivatives of benzene, and the accompanying formulae are those generally accepted as expressing the relations of the hydrocarbon camphene, the alcohol borneol, and the ketone camphor to hexahydrocymene, the hexahydrogen derivative of methylisopropyl benzene.



Hexahydrocymene. Camphene. Borneol. Camphor (Bredt).

(2) Although many naturally occurring alcohols (e.g., borneol, terpineol, and so on) in essential oils are derivatives of the terpenes, it is convenient to mention them separately. They are usually associated in Nature with their esters (compounds of the alcohols with acids—in this case, of the fatty series); for instance, linalol ($C_{10}H_{18}O$) is accompanied by linalyl acetate ($C_{10}H_{17}O \cdot COCH_3$) in lavender oil, and geraniol ($C_{10}H_{18}O$) by geranyl

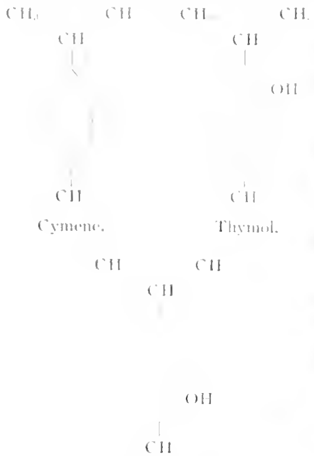
Common Name of the Oil	Source	Natural Order	Chief Constituents.
Turpentine ...	*Pinus Australis* and *Pinus taeda*	Pinaceae ...	Pinene, $C_{10}H_{16}$, Dipentene, $C_{10}H_{16}$ } (T).
Juniper	*Juniperus communis* ...	Pinaceae ...	Pinene, cadinine ($C_{15}H_{24}$) (S), and "juniper camphor" (formula unknown).
Nutmeg ...	*Myristica fragrans* ...	Myristicaceae	Terpenes.
Cassia	*Cinnamomum cassia* ...	Laurineae ...	Cinnamic aldehyde.
Cinnamon ...	*Cinnamomum xylanicum*	Laurineae ...	Cinnamic aldehyde.
Camphor ...	*Cinnamomum camphora*	Laurineae ...	Camphor (K), terpineol (A), eugenol (P).
Mustard ...	*Brassica nigra*	Cruciferae ...	Allyl isothiocyanate (En).
Rose	*Rosa damascena* ...	Rosaceae ...	Geraniol (G), Citronellol (G), esters and a solid stearoptene.
Bitter almond ...	*Prunus amygdalus*, var. *amara*	Rosaceae ...	Benzaldehyde and (unless freed from) hydrocyanic acid.
Lemon	*Citrus medica*	Rutaceae ...	Terpenes, citral (A) $C_{10}H_{16}O$.
Orange	*Citrus aurantium* ...	Rutaceae ...	Limonene $C_{10}H_{16}$ (T), and aldehydes.
Bergamot ...	*Citrus bergamia* ...	Rutaceae ...	Limonene $C_{10}H_{16}$ (T), linalol $C_{10}H_{18}O$ (G), linalyl acetate $C_{12}H_{20}O_2$ (E).
Rosemary ...	*Rosmarinus officinalis*	Labiatae ...	Terpenes, borneol $C_{10}H_{18}O$ (A), camphor (K) $C_{10}H_{16}O$.
Lavender ...	*Lavandula vera* ...	Labiatae ...	Linalol (G) and esters (acetate).
Peppermint ...	*Mentha piperita* ...	Labiatae ...	Menthol ($C_{10}H_{20}O$) (A), menthyl acetate ($C_{12}H_{22}O_2$) (E).
Eucalyptus ...	*Eucalyptus globulus* ...	Myrtaceae ...	Cineol ($C_{10}H_{18}O$) (A), and phellandrene ($C_{10}H_{16}$) (T).
Bay	*Pimenta acris*	Myrtaceae ...	Eugenol (P), and olefinic terpenes.
Cloves	*Eugenia caryophyllata*	Myrtaceae ...	Eugenol (P), and caryophylline $C_{15}H_{24}$ (S).

TABLE 50.

tiglinate $CH_3 \cdot CH : C \begin{matrix} CH_3 \\ COO \cdot C_{10}H_{17} \end{matrix}$ in oil of geranium.

(3) Of frequent occurrence in volatile oils are the following phenols:— eugenol $C_{10}H_{12}O_2$, thymol and carvacrol.

The relations of the latter two to each other and to cymene (p-methylisopropyl benzene) are expressed by the following formulae:



Cymene. Thymol.

Carvacrol.

(4) Of this class the following aldehydes constitute a large percentage of many volatile oils:—cinnamic aldehyde, $C_6H_5(CH : CH \cdot CHO)$, benzaldehyde, $C_6H_5 \cdot CHO$, and anise aldehyde, (aubépine) $C_6H_4(OCH_3)(CHO)$, while the ketones are represented by pulegone ($C_{10}H_{16}O$) in the oil of pennyroyal. Table 50 (see page 457) will show how the constituents of the essential oils remain fairly constant throughout each natural order, and will indicate the occurrence of the various chemical substances above mentioned, in their respective oils. The letters in brackets after the names of the constituents refer to the particular groups of chemical compounds to which the latter belong.

T—Terpenes.
S—Sesquiterpenes.
A—Alcohol derivatives of terpenes.
Al—Aldehydes.
K—Ketone derivatives of the terpenes.
En—Produced by enzyme action.
D—Aldehyde derivatives of the terpenes.
E—Esters.
G—Alcohols of the Geraniol series.

By the courtesy of Messrs. Schimmel & Co.

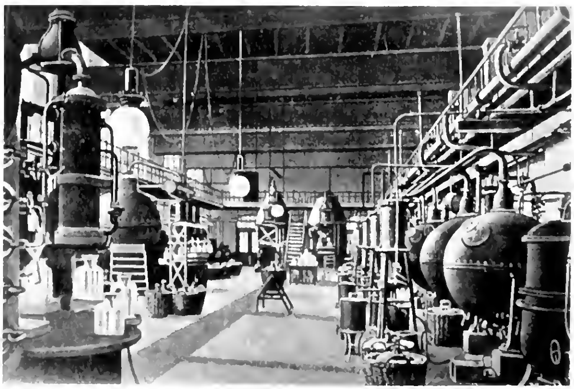
FIGURE 484.

A huge still of fifty thousand gallons capacity.

When we consider the high prices reached by some of the essential oils, Otto de Rose at the present time almost attaining seventy shillings per ounce, it is evident that they offer great temptation to the manufacturers and dealers to impoverish them by adulteration or partial removal of valuable odoriferous constituents. The usual adulterants are alcohol, terpenes, fixed oils and resins. The presence or absence of all of these substances may usually be ascertained by the odour of the oils and by the determination of their physical and chemical constants, the figures so obtained being compared with those generally accepted for a genuine oil.

The methods of examination may be divided into the following classes:—

(1) Physical.
(2) Chemical.



By the courtesy of Messrs. Schimmel & Co.

FIGURE 485.

A room in the Distillery of Messrs. Schimmel & Co., the largest in the world.

Concerning the former, the routine operations consist of the determination of the specific gravity and other constants, such as the optical rotation, refractive index, and solubility in a given solvent. The congealing (or melting) point, residue on evaporation, and the behaviour of the oil on fractional distillation also offer valuable clues as to any sophistication.

The specific gravity is usually determined at 15·5° C in a small apparatus known as the Sprengel tube.

This tared tube (see Figure 490) is filled up to the mark on the larger limb at the specified temperature, weighed, and the specific gravity calculated by deducting the weight of the tube and dividing the remainder by the weight of an equal volume of water at the same temperature.

The optical rotation is usually determined by means of the modern half-shadow polariscope in a tube one hundred millimetres long, while the refractive index is found preferably by means of an Abbe refractometer, fitted with a constant temperature arrangement.

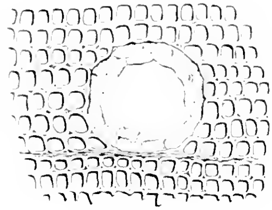


Figure 486.
Oleo-resin duct of *Pinus*.

Fractional distillation is conducted in a Ladenburg flask, illustrated by Figure 488, and the solubility determination in a stoppered and gradaated glass cylinder, having a capacity of ten cubic centimetres.

The chemical quantitative methods of testing applied to the analysis of essential oils are exceedingly numerous, so that only a few of the most typical and generally employed will be referred to.

These consist of the estimation of esters, free alcohols, and other well-defined constituents, such as phenols and aldehydes.

The principle of the determination of esters depends upon their being hydrolysed by boiling with alcoholic potash, according to the equation:—

$$RA + KOH = R \cdot OH + KA$$

Where R is the alkyl and A the acid radicle.

The quantitative analysis of oils containing free alcohols consists of converting the latter into their acetyl derivatives by boiling with acetic anhydride, and saponifying the separated product by boiling with a standard solution of alcoholic alkali as represented by the above equation. Many constituents of the volatile oils, which are practically quite insoluble in water, readily form soluble compounds with solutions of inorganic bodies. Aldehydes, for example, are dissolved by sodium hydrogen sulphite, and phenols by potassium hydroxide solution. The residual oil, non-aldehyde or non-phenol, as the case may be, is left floating upon the aqueous solution, and may be estimated by bringing it into the graduated neck of the special flash used for this purpose, by adding more of the aqueous solution, or of water, and reading the volume of the oil there indicated. One of these so-called "Cassia" flasks, usually made of two hundred cubic centimetres capacity, with the neck graduated from 0·1 to ten cubic centimetres, is seen in Figure 489.

As the perfume industry is dependent upon products of the animal as well as the plant world, we will now, therefore, consider the sources and properties of a few animal and artificial substances used in the art.

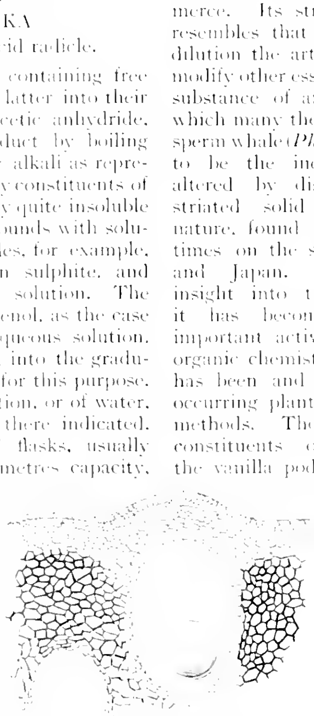


Figure 487.
Lysigenous cavity in the pericarp of the orange, containing a drop of ethereal oil.

Of the former articles, musk ranks first in importance, but mention will also be made of civet and ambergris. These materials are, properly speaking, not perfumes, but, by their special characteristics, e.g., their persistent but not sweet odour, serve to "fix," as it is technically termed, other odours which are too delicate and fleeting. Indeed, in many cases these products possess a very disagreeable smell, as they are frequently in a state of partial decomposition.

Musk is a very valuable substance obtained from the preputial follicles of the musk deer (*Moschus moschifera*), a graceful animal inhabiting Central Asia. The males bear a small sac, containing the soft, unctuous and granular secretion which possesses a penetrating ammoniacal odour. Civet, another of the above-mentioned animal products, is obtained from the perineal glands of the civet cat (*Viverra civetta*) and other species of Viverra (Natural Order Carnivora). It is imported from Africa and the West Indies. The animal is a domestic one and the natives extract, usually twice a week, the secretion from the glands, and place it in the horns of buffaloes, in which form it is usually seen in commerce. Its strong characteristic odour somewhat resembles that of musk, and in a state of great dilution the article is advantageously employed to modify other essences and perfumes. The remaining substance of animal origin, Ambergris, concerning which many theories are afloat, is a product of the sperm whale (*Physeter macrocephalus*), and is believed to be the indurated faeces, probably somewhat altered by disease. It is an opaque, greyish, striated solid of irregular shape and friable nature, found floating in large masses at various times on the surface of the sea near Madagascar and Japan. With increased knowledge and insight into the constituents of odorous plants it has become possible to isolate numerous important active ingredients: and the science of organic chemistry in one of its important branches has been and is directed to producing naturally occurring plant and animal principles by synthetical methods. The more important isolated odorous constituents of plants include vanillin, from the vanilla pod, and coumarin, from the tonquin bean. Both these principles are now produced by synthetical methods: vanillin ($C_6H_3(COH)(OCH_3)(OH)$), from the glucoside coniferin ($C_{16}H_{22}O_8+2H_2O$), and coumarin ($C_9H_6O_2$), the δ-lactone of coumarinic acid, from salicylic aldehyde $C_6H_4(OH)(CHO)$.

Chemical compounds without number are now prepared for use in the manufacture of perfumes; but only those of definite constitution will be mentioned.

Heliotropin, $C_6H_3 \begin{cases} CHO \\ O \\ O \end{cases} > CH_2$, possesses a powerful odour of Heliotrope, and is obtained by the oxidation of safrol, $C_{10}H_{10}O_2$; aubépine or anisic aldehyde, $C_6H_4(OCH_3)(CHO)$, reproduces the odour of May blossom; while "Ionone," an artificial violet perfume, for which a patent was taken out by Tiemann and Krüger, is prepared by a complicated series of reactions, by the condensation of citral with acetone.

Another product in extensive use is artificial musk, which fairly successfully imitates the odour of the natural article, although the chemistry of the latter is quite unknown.

The constitution of this substance, which has been the subject of numerous patents (Baur, and so on), varies, but the commercial article consists of a nitrated hydrocarbon, often butyl-xylyl-propyl-ketone

$$(C_3H_7 \cdot CO \cdot C_6H_2 \begin{cases} C_4H_9 \\ CH_3 \\ CH_3 \end{cases}).$$

Other "synthetics" include compounds to represent natural Neroli, Rose, Hyacinth, and Lilac, the odour of the last named being closely imitated by the well-known body terpineol ($C_{10}H_{17}OH$). This chemical is inexpensive, and being unaffected by heat and alkalies, constitutes one of the most valuable perfumes for toilet soaps, although it is an ingredient of many of the best spirit perfumes on the market. The compound synthesised by Baeyer has the chemical formula:—

C(OH)(CH₃)

CH₂ CH₂

CH₂ CH₂

C:C(CH₃)₂

With regard to artificial rose oil, almost innumerable attempts have been made to imitate the "smoothness" and delicacy of the natural otto, but none have met with any great success. During the last year, however, great advances have been made in this direction by employing various substitution products of the alcohols of the geraniol series, and also by using phenyl-ethyl alcohol and its acetate. The natural constituents of Otto de Rose (see Table 50) are geraniol, citronellol, and so on, and mixtures of these naturally occurring principles constitute such preparations as "rhodinol," "roseol," and so on, which are supposed to approach in fragrance the aroma of the genuine oil.

In the foregoing paragraphs of this article we have become acquainted with the names and elementary properties of some of the more common constituents of the essences retailed in the shops.

We will now proceed to study the relations of the properties of these substances to each other, when used to imitate the odours of fresh flowers and in making ordinary "bouquet" perfumes. The solutions of numerous blended simple materials popularly known as "scents" or "perfumes" seem to have become invested with a certain air of sanctity, and it is hoped that the following outline of the methods employed in their manufacture will detract from them some small amount of the mystery they so obstinately retain.

It is not intended here, however, to in any measure deprecate the perfumer's art, which is one of the oldest known, and one from which chemistry has not removed much empiricism, but merely to remove from the average mind its ignorance of the nature of floral essences, probably caused by many mythical terms of description.

Figure 488. Ladenburg Flask.

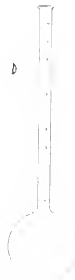


Figure 489. Cassia flask.

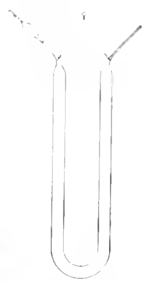


Figure 490. Sprengel tube.

In studying the art of the perfume industry, we can clearly and conveniently differentiate between the following classes of substances which are in constant use:—

(1) "Primary materials," which for our purpose include essential oils, artificial perfumes, various animal and plant substances, and pomades (to which reference will be made later). All these constitute the foundations of other intermediate preparations, which are included in the subsequent synopses (2, 3, and 4).

(2) The so-called tinctures, extraits, spirits and infusions.

(3) The specialities of different firms, "Concretes," and other substances, the formulae of which are not published: the last-named being, in many cases, liquids possessing the characteristic odours of defined flowers, and which are intended to be softened, fixed or otherwise modified with other materials.

(4) Compound preparations of more or less known or evident composition, or which can be imitated with a fair degree of accuracy. These could have been classed as "primary materials," except for the fact that they are of complex constitution, whereas the term is conveniently reserved for substances representing the properties of one particular plant. These complex compounds are blended mixtures of simple substances (essential oils, synthetics), which constitute useful bases of constant composition, and which have usually been at some previous time secret preparations similar to those included in (3). The pomades, *vide* (1), which have been mentioned on two previous occasions, are prepared in the south of France by two distinct methods, involving the removal of the odorous constituents of flowers by means of a mixture of fats, usually suet and lard, although olive oil and other fixed oils are sometimes used. The impregnation is either conducted by warming the mixture of flowers and fat in a steam-

jacketed pan to 60° C., or by *enfleurage*, a method of cold extraction, which consists of allowing the flowers to remain in contact with the fat for a certain time, and replacing them at intervals by fresh ones until the butyraceous mass has acquired a sufficiently strong characteristic odour.

The pomades obtainable include Jasmin, Rose, Tuberose, Cassie, Violet, Orange flowers, and so on.

The substances, here designated as "primary materials," include many other products of the plant world, of which special mention has not been made; such are Tonquin beans (*Dypteryx odorata*), Vanilla pods (*Vanilla planifolia*), and Storax (*Liquidambar orientalis*).

Our second class of articles (2), comprises solutions of the "primary materials" in solvents. No absolutely definite rule stands for the exact application of the names there mentioned. Usually, and here, the tinctures mean solutions of vegetable substances, such as benzoin and the soluble constituents of Tonquin beans, in alcohol; the extraits refer to the alcoholic extracts of pomades; the spirits, to solutions of essential oils in alcohol; while the infusions represent liquids containing the soluble constituents of substances such as musk and ambergris, in special solvents.

With regard to the preparation of these semi-pharmaceutical products very little need be said.

The extraction of pomades is conducted on a large scale in France, by treating them in a specially designed emulsifying machine with alcohol, the process occupying about a week, while the operation for small quantities is carried out by macerating the fatty substance with the menstruum in closed vessels, with occasional stirring, for about a month.

The tinctures and spirits, usually being simple solutions of single substances, offer no difficulties in practice, but the successful manipulation of an infusion requires a little skill; that of musk, for instance, necessitating trituration or "rubbing down" of the material with hot water, and digestion for a fortnight with alcohol. Civet is usually mixed with powdered orris root, extracted in a similar manner, and finally improved by the addition of potassium carbonate.

The pomades and extraits, although far superior to alternative preparations as regards the delicacy of the odours they represent, are used only to a small extent in England, but in France they enjoy practically universal employment. In this country they are replaced by the so-called "concretes" (mentioned in (3)), which are essentially pomades without the fat. They are not designated in this treatise as "primary materials" because their methods of manufacture, although usually consisting of extracting the flowers with solvents, often petroleum ether, are guarded as trade secrets, and also because in many instances they are believed to consist, at least partially, of artificial substances.

These preparations are sent out under various copyright titles, in the form of concentrated semi-liquid products, and are met with representing the flowers already named in our consideration of the floral pomades.

It is quite possible to make an expensive and, in this respect, good perfume from a simple mixture of only essential oils dissolved in alcohol, but as preparations of this type are deficient in lasting power, various "fixers" are employed to impart the necessary stability. These fixing preparations include the already-mentioned infusions of animal products, and also many synthetic and proprietary articles possessing slow or slight volatility. Although it is impossible to teach, if such were even ever attempted, the art of perfumery in a book, it is quite easy to classify two distinct varieties of materials which give character and permanency to an essence, namely:

(1) "Light" or delicate odours, e.g., volatile oils and extraits of pomades respectively.

(2) "Fixatives," including infusions, tinctures of balsamic resins like benzoin and balsam of Peru (from *Myroxylon pareira*), and also many proprietary specialities, obtainable under various fantastic names.

It is in the judicious and minute attention to the blending of the articles of these two classes that the skill of the perfumer manifests itself; for it is only by the possession of an extremely well developed olfactory sense, and profound knowledge gained by protracted experience, that the odours of particular flowers can be successfully imitated, or the creation of novel and pleasing combinations can be accomplished. With even a small amount of practice it is possible, however, to acquire the art of such processes as the "softening" of one or the "enriching" of another odour; but it is by experience alone that one may become intimately acquainted with the affinity of odours and their incompatibility.

As the latter portion of this article only considers the preparation of the common handkerchief essences, it must not be supposed that this is the only or even the largest branch of the industry.

It is impossible in a small space to deal with the composition of perfumed waters (Lavender, Aqua Mellis, and so on), Eau de Cologne, powder and solid perfumes, or even to review the widely different methods adopted for perfuming toilet soaps and other preparations, such as hair lotions, cosmetics, and dentrifices.

It is hoped, however, that the original object has at least been partially accomplished; that of describing the sources, modes of preparation, and properties of a few of the chief substances employed in perfumery; of indicating the methods of manipulation involved in producing the spirituous essences familiar to us all, contained in their attractive cut glass bottles, artistically decorated with smart labels and the inevitable ribbon; and of demonstrating how science has improved upon the ancient methods of extracting the various odoriferous bodies, and has presented an important and continually increasing industry with ingenious apparatus, along with sound, practical and economical processes.

THE NEW ASTRONOMY.

PROOFS OF THE IMPACT THEORY OF COSMIC EVOLUTION

By PROFESSOR A. W. BICKERTON.

I WISH to thank Mr. O'Halloran for his letter on the death of energy in the September issue of "KNOWLEDGE," in which he describes some of the observational and logical evidence tending to prove the theory of the third body. In contrast I may quote the remark made a short time ago by one of our ablest astronomers, who said: "I own your ideas are very suggestive but necessarily incapable of proof." This opinion is shared by other official astronomers. Clearly such an opinion cannot be held by those who have read the mass of evidence published in "KNOWLEDGE" since August, 1911. This alone is quite convincing; yet much of the evidence now available has not yet appeared even in "KNOWLEDGE"; one amongst other reasons being that some of it has been observed or made known subsequently to the publication of those articles and letters. This is especially the case with the wonderful evidence furnished by Nova Geminorum.

There are two fundamental oversights regarding the New Astronomy that seem to be made by almost all astronomers. First, they look upon impact as random and destructive; whereas impact is brought about by many agencies and produces definite results often of amazing complexity. Hence impacts are really a law of Nature, and constructive. Impacts are probably one hundred thousand times as frequent as mere random encounters of stars, situated as our Sun is, would be. The other oversight of many astronomers is the lack of realization on the one hand of the thermodynamic intensity of the phenomena of new stars, and on the other hand of the calorific power of stellar impact. Nova Persei was but a feeble star compared with other historic examples. Yet at its maximum it had ten thousand times the intensity the Sun would have, were both seen by a being situated at the same distance from either star. The Sun at three light years' distance would present the appearance of Nova Persei. Yet the pace of progression of the flash of light that lit up the Perseus nebula shows this nova to be three hundred light years away: that is when placed one hundred times as far away it was as bright as the Sun would be at three light years' distance. 100^2 is 10,000; that is the comparative intensity of Nova Persei in terms of solar units. The Sun, if stoked by fuel, would require six hundred times the known coal-fields of the Earth per minute to keep it going. Hence as a bonfire Nova Persei would require $600 \times 10{,}000$, or six million times the known coal-fields of the Earth to be burnt each minute of maximum to produce such a blaze. Such is the energy of a nova. What is that of grazing suns? Were express trains meeting at three hundred miles a second, which is the speed we may consider that two stars grazing meet at, the collision would have three hundred and twenty-four millions times the energy it would have were the trains meeting at a mile a minute. The thermatol or molecular kinetol, or heat energy of unit mass, would be twenty-seven million degrees. A velocity of three hundred feet a second is approximately the mechanical equivalent of heat; thermatol is proportional to velocity squared, hence three hundred miles a second is clearly five thousand two hundred and eighty squared times as great as the mechanical equivalent; that is, over twenty-seven million degrees thermatol. So a graze of suns exactly corresponds, both in power and equivalent energy, with the observed data of Novae. The observed complex light curve of Nova Persei, which was most completely made, corresponds exactly with that dynamically deduced. The light curve of Nova Geminorum was not able to be so well observed, yet a superposition of the best observed curves shows that the light curves of the two closely resemble one another. Whilst the light curves of Nova Geminorum are not so good as those of Nova Persei, the series of spectrograms obtained are much finer. The Cambridge Spectrograms recently shewn in the Library of the Royal Astronomical Society are minutely perfect and full of detail. Their details are confirmed by each character being shown in many of the series. There is not a physical or chemical fact disclosed by these duplicated details but was deduced and published a long time before the spectrograms were photographed; whereas the perfection of these marvellous spectra supplies physical data that pulverize and blow, to the four winds of the heavens, every fibre of any known theory save that of the third body.

These Novae demonstrate beyond any doubt the fact that they are third stars grazed from colliding suns. Yet Novae so constantly alike are only one of the scores of celestial phenomena, equally striking in the coincidence of deduction and observed fact. Mr. S. N. E. O'Halloran's letter is chiefly devoted to Steinmetz' article showing Kelvin's oversights in coming to his idea of the death of energy. In "KNOWLEDGE" (December, 1911) I show some of the agencies that deductions prove must act together to produce an aggregation of primordial matter, forming cosmic systems of the first order. In *The Phil. Mag.* for August, 1900, I showed that the configuration of our Galaxy suggests it to be made up of a primordial and an old cosmic system interpenetrating. Kapteyn's statements show that observation confirms this deduction.

In "KNOWLEDGE" for December, 1911, the

whole evolution of the Galaxy is deductively shown. Let us see how far facts confirmed the deductions. We assume that the two Nubeculae and the Nebula of Andromeda may be independent sidereal systems. The other white nebulae we deduced should avoid the Milky Way; which a summing up of the latest observations shows they do. On the other hand, as deduced, gaseous nebulae of all kinds are found in the Milky Way; as are nearly all the objects deduced as being produced by the impact of suns. These are temporary, variable, double and Wolf-Rayet stars; spectroscopic binaries, star clusters and planetary nebulae; almost all of which are in the Galactic Zone or the Nubeculae.

The investigations of Victor Anestin and the Rev. T. E. Espin show conclusively the coincidence in position of many of these celestial objects and those parts of the Galaxy where stars tend to crowd.

There is a vast mass of other deduced coincidence that it would be most valuable work to confirm; work of such a nature that the equipments of great observatories would be required; yet amateurs could do much valuable work. There is not a single character of all the complex types of any one of the variable stars known but can be deduced as the product of impact of some kind or other.

The pairing of variable stars was deduced and afterwards confirmed: the double variability of double stars was anticipated in the same way, so was the association of double stars with nebulae. Not merely were the constancy of some and the irregularity of others, and the many variations of the light curves of stars deduced, but the cause of their frequent nebulosity at minimum has been most clearly shown.

So recondite were many of the deductions made and published a third of a century ago, that I thought it impossible that much of the work would be confirmed in my lifetime. I had no conception even that in the Earth's whole history many of the deductions of the researches now proven to be true by observation would ever be so. I thought that, in time, the kinetics and kinematics would be seen to be so sound that they would serve as working hypotheses. Of course, it is the arming of the telescope with the prism and photographic film that has placed such unexpected power in the hands of observers. The above is a broad outline of the generic coincidence between observation and fact. I have not attempted in any of these classes to give the details. I would, however, ask any astronomer who is not prepared to accept the Impact Theory of Cosmic Evolution to answer the one question: How does he account for the pairing of many variables, and the variability and double variability of many binaries? There must be some law at work; for in each case the statistical probabilities are many millions to one against such an occurrence being chance.

So far as I know there never has been a single argument against this generalization. Every deduction has been examined over and over again by experts and found to be soundly based on natural law. Its vast scope is the only thing that made it suspect in New Zealand, and no celebrated English astronomer, except Father Sidgreaves, has ever seriously studied it, and he has approved it in unmistakable terms. Two New Zealand astronomical mathematicians, C. E. Adams, Government Astronomer, and E. C. Gifford, Herschel Scholar of Cambridge, have devoted themselves to a most detailed examination of every branch of the correllation, extending over a score of years, and these able astronomers declare that observational astronomy would a decade ago have been where it is now had this generalization been used from its publication as a working hypothesis to guide research. Professor Rutherford, F.R.S., who investigated it in great detail when studying in my laboratory in New Zealand, has repeatedly spoken of his high opinion of the theory as a working hypothesis.

One thing is clear: that in the study of celestial collisions and interpenetrations the problems must be taken in two parts: the actually meeting parts that coalesce and form a third body, and the parts that escape collision, but are profoundly modified by the event. The physics of the two are so dissimilar that they must receive separate investigation, whether we are studying the collisions of suns, nebulae, meteoric swarms, or sidereal systems; whether the impact be a mere graze or a deep case of whirling coalescence. Always the chemical and thermodynamic problems are quite unlike.

It is the opinion of those who have known the whole generalization that it introduces many scores of principles not yet recognised by science. This is apart from its astronomic value. Yet, in this respect it is now quite proven. Years ago Gifford said of it: "In 1878 the facts on which the impact theory relied were few, though sufficiently striking. Now they are innumerable."

Many favourable criticisms from many well-known scientific men have appeared respecting the long illustrated articles published in "KNOWLEDGE" (September, 1911, *et seq.*); and although many journals have printed long appreciations of these articles—several appreciations running into many thousands of words—*The Scientific American* occupying two pages, newspaper size; on the other hand, no words of adverse criticism have ever appeared, nor has there been any adverse comment on the widely-reported Royal Institution lectures. With all this publicity no learned society and no university has ever debated the generalization, and this in the face of the fact that recent observed discoveries have disproved all the old theories of astronomical origin. Yet these same observations have demonstrated the accuracy of this theory of cosmology down to the minutest detail.

What is the scope of this generalization? It shows the genesis of every body and system in the universe and of the very sidereal system itself. It interprets the details of every light curve and every complex spectrogram. It shows there is another [illegible] power in Nature besides gravitation, consisting of a series of [illegible] forces acting chiefly on elements of low atomic weight, and hence appropriately called Levitation. Every step of this reasoning has been examined by able mathematical physicists, and stated to be mathematical "*verae causae*." This new discovery alone is of such scientific importance as to absolutely remove the cosmic application of the theory of dissipation of energy, with its dismal doctrine of eternal death. It shows the scheme of creation to be infinite and immortal. It shows that gravitation and levitation mutually correllate each other and are complementary agents in an eternal rhythm. Gravitation tends to collect and concentrate the heavy elements into dark stars, and may be looked upon as the chief factor of death; whilst levitation collects the light elements and gives birth to primordial systems—cosmic systems of the first order. Then, by the interpenetration and interfusion of the two, we get virile sidereal systems; of which our galaxy is a type. Eminent astronomers tell us in unmistakable language that within this vast sidereal system of which the solar system is a part, they can observationally trace every characteristic that deduction says such a mode of origin should present. The onrush of the primordial and effete systems can still be traced. The rejuvenating mechanism of eternal physical life is thus actually seen in process within the galaxy itself. The whole mechanism of cosmic re-birth being thus not merely shown to be true by irrefutable dynamical deduction, but also confirmed, decades afterwards, by the latest observations of the most refined of astronomical methods.

CORRESPONDENCE.

FERTILISATION OF THE FIG.

To the Editors of "KNOWLEDGE."

SIRS,—The interesting questions raised by your correspondent "L.L.J.", and some similar inquiries addressed to me by other readers of "KNOWLEDGE" with reference to my article on the above subject in the August issue of this journal, call for some further explanations, for which I trust you will be kind enough to afford space in these columns, and which I ought perhaps to have incorporated in that article.

The article in question was based, as stated, upon the recent interesting investigations made by Ravasini and communicated by Tschirch on the wild and cultivated figs of Italy. Ravasini has himself just published his results in a German memoir, but I might have pointed out more explicitly than I did that, as suggested by "L.L.J.", the complete life cycle of the Fig, as worked out by Ravasini in Italy, is by no means realised in more northerly countries. As cultivated in Britain, the fig tree produces only two generations of inflorescences each year, and of these only one, as a rule, ripens outside. The first generation or crop is produced in early summer from buds of the former year, the second in autumn from those on the spring shoots; these apparently correspond respectively to the "pedagnuoli" and the "cimaruoli" of Italy and the Mediterranean countries generally, the "fiori di fico" being absent from the northern countries, though by growing selected varieties in a hothouse all three crops may be obtained. In outdoor plants in this country, the first shoots usually appear in May and bear young figs in July or August; but these rarely ripen properly owing to the shortness of our summer. The later midsummer shoots produce young inflorescences, and these do not develop until the following spring—it is upon these alone that the British grower can depend, as a rule, for a crop of ripe figs.

I have not yet been able to ascertain whether or not experiments have been made in this country concerning the production of fertile seed by figs grown here, though I have examined microscopically large numbers of "ripe" figs grown in various parts of Southern England and the Channel Islands, and have never found either wasps, male flowers, nor embryo-containing seeds. It should, of course, be noted that the inflorescences become enlarged and succulent quite apart from fertilisation, though they are not mature in the sense of containing fertile seeds as do those imported in the dried condition from Asia Minor. Until recently, it was thought that the production of mature seed-bearing figs was absolutely dependent upon having in the vicinity of the ordinary female tree one or more of the male trees (the "Caprificus"), and excellent results in the form of improved fruits have been obtained by introducing the "Caprificus," or the Wild Fig, into countries where only the female fig tree had been previously cultivated—the pollinating wasps being, of course, introduced simultaneously with these plants which they infest. This course was adopted, for instance, in California a few years ago, and had already been resorted to in various European countries. The wasps are extremely small, only about a millimetre across, and can, therefore, easily enter the narrow orifice of the inflorescences. However, until the question of the fertilisation of the fig has been thoroughly investigated in Britain, it is difficult to say in how far Ravasini's observations apply to figs grown outside of Italy and the other Mediterranean countries. It has been suggested that the better maturation of the fruit resulting from the intervention of the wasps or from "caprification" is attributable to the stimulus induced by the insect's ovipositor, and not to the pollination of the female flowers, and that the mere thrusting of a straw into the inflorescence may have the same effect. Moreover, some recent writers have described the production of fertile seeds, capable of germinating and giving rise to new fig plants, in the complete absence of the male flowers and the wasps—that is to say, should these observations be confirmed, the fig will have to be added to the small but growing list of plants in which parthenogenesis is known to occur either occasionally or regularly, the egg-cell in the ovule developing into an embryo without the entrance of a male germ-cell.

I must, however, apologise for the length of this communication, and for the lack of definite information which I have so far been able to obtain concerning the life cycle of the fig tree as grown in Britain. As a matter of fact, one of the reasons for my having contributed to "KNOWLEDGE" the gist of Ravasini's important work on the fig in Italy was the hope that some of your readers might feel inclined to take up an interesting branch of study and help in clearing up some of the difficulties of the "fig problem." It would be interesting to have the results of observations in different parts of this country, which might contribute to our knowledge by answering the following and other questions.—Does the ordinary fig tree produce any male flowers in its inflorescences? Does it produce fertile seeds containing an embryo and capable of germination? Does the production of such fertile seeds depend upon the presence of the male tree or Caprifig? Do the fig wasps ever occur in the inflorescences of the ordinary Fig in this country? Does the Fig produce fertile seeds by parthenogenesis?

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EDIBLE AND POISONOUS TOADSTOOLS.

By SOMERVILLE HASTINGS, M.S., F.R.C.S.

Is it edible? Is it poisonous? These are usually the first questions that come to the mind of anyone who is shown a toadstool of any kind, quite irrespective of whether the person concerned is accustomed to regard the articles of his diet with peculiar interest or not. It is perhaps a very primitive instinct that prompts us to enquire as to the food value of anything we notice for the first time.

In this short article it is proposed to say something about the edible and poisonous qualities of mushrooms and toadstools and then to consider of what use these properties are likely to be to the fungus plant.

An exceptionally large number of cases of poisoning by toadstools occurred during the present autumn (1912), particularly in the rural districts of France. On September 11th last, no fewer than twenty cases, six of them fatal, were reported in the *Figaro*, of Paris. Of our English species one hundred and ninety-four are mentioned by Dr. Cooke as having been described as edible by different authorities, and of these Dr. Cooke has himself sampled sixty-nine in sufficient quantity to be sure that they are harmless. About thirty or forty species are described as poisonous: many of them, it would appear, upon rather slender evidence: for when one begins to enquire why they are considered poisonous, one is met by considerable difficulty, for not infrequently one finds that a species described by one writer as poisonous is recommended by another as edible, especially when the writers are referring to different countries. No doubt many of these discrepancies are the result of mistakes in the identity of species; but the character of the soil, the amount of moisture which it contains and the temperature at which the toadstool develops would appear to be factors of considerable importance also. Thus the Scarlet Fly Cap (*Amanita muscaria*) (see Figure 493), a particularly definite and easily recognised species, of the poisonous qualities of which in this country there is ample evidence, is stated by more than one author to be regularly eaten as an article of diet in parts of France and Russia. Even in the same locality the chemical composition of fungi seems to vary considerably, and cases of poisoning, some of which resulted in death, have even been recorded in connection with the Common Morel (*Morchella esculenta*). (See Figure 496.) The proportions of poisonous substances in individuals of the same species have also been shown to vary considerably. Some exist only for a short time in the life of the toadstool, and others develop only with commencing decomposition. Helvellic acid, a very poisonous substance, is present in mature and old specimens of *Helvella esculenta*, but is entirely absent in young and fresh.

FIGURE 491.
The Death-cup (*Amanita phalloides*).

Choline, a comparatively harmless alkaloid which has been isolated from several species of toadstool, changes on decay to the deadly neurine, which resembles in its action muscarine, the poisonous principle of the Scarlet Fly Cap.

Some of the toxic substances are volatile, others are destroyed by heat and most are soluble in water, especially if acidulated or containing salt. Frédéric Géraud gives a recipe for preparing every kind of toadstool, even the most poisonous, for the table. He has himself repeatedly tried it and proved it to be effective. The toadstools are cut up into small pieces and steeped in water to which vinegar or salt has been added, for at least two hours. They are then washed thoroughly and boiled for half an hour, washed again, and may then be prepared as desired. It is wonderful what extraordinary things some people will try to eat.

The amount of a poisonous toadstool that is required to give rise to symptoms of poisoning of course varies with the species taken; for some are much more poisonous than others. But there are also marked differences in susceptibility in different individuals. Where several people have partaken of the deadly dish, and are consequently affected, the severity of the symptoms in no way corresponds with the amount of the toadstool eaten.

It may be useful here to enumerate the species of whose poisonous properties there is definite evidence.

The Death-cup toadstool (*Amanita phalloides*, Figure 491) is a harmless-looking fungus with an earthy, and not unpleasant, smell. Its cap is usually pale olive green in colour, rather slimy,

Figure 492.
The Liberty Cap (*Psilocybe semilanceata*).

and has one or two largish white scales sticking to it. These are parts of the volva which enclosed the toadstool when immature. Other remains of the same are seen in the cup at the base of the stem. The toadstool has white gills and a white ring near the top of the stem. It grows in woods. Though so innocent-looking, it is responsible for more than half of the cases of toadstool poisoning and for ninety per cent. of the deaths. Victor Gilet found one hundred and fourteen cases recorded in the literature, and seventy-three of these were fatal. It is probable that this death-rate of sixty-four per cent. is rather too high, because fatal cases are much more likely to be recorded than those less severe. The poisonous properties of the Death-cup appear to be mainly due to an albuminous substance, phallin, which is obtained from an aqueous extract of the fungus: it is not unpleasant to the taste, but is very fatal when administered to cats and dogs. It dissolves the blood corpuscles and coagulates the blood, and on this action its poisonous properties mainly depend. The symptoms produced by phallin are not, however, exactly like those which develop when the Death-cup toadstool is eaten, and it is very likely that other toxic substances exist as well. Three other poisonous substances have been described by different observers. One of them, amanitine, is purely narcotic in its action; the others, bulbosine and phalloidine are alkaloids. Not till eight to twelve or even twenty-four hours after the toadstool is eaten do symptoms usually develop. The patient then begins to suffer from what might easily be mistaken for severe cholera with nausea and watery diarrhoea, cramps, convulsions and collapse. Death may take place about the second or third day, or the condition may improve. Often, however, this improvement is only temporary, for within two or three days the symptoms return, and a condition resembling severe jaundice, with stupor, develops, and death occurs about the fifth or seventh day.

Amanita verna is said to give rise to similar symptoms.

The Scarlet Fly Cap (*Amanita muscaria*, Figure 493) is probably the best known of our toadstools. It has a scarlet (at times orange) cap, dotted all over with white warts. These warts are the remains of the volva which covered the toadstool when young. There is no definite cup, but the base of the stem is swollen. The gills are white, and there is a well-marked ring. The fungus is found most abundantly in the neighbourhood of birch trees. In Kamschatka and North-Eastern Asia this fungus is stated on good authority to be regularly used to produce intoxication. The toadstools are collected in the hottest months and hung up to dry. When required for use, they are rolled up and swallowed whole. One large or two small will, in a couple of hours, produce an intoxication that lasts for twelve to twenty-four hours. A feeling of giddiness with exaltation and delirium is produced. The face becomes flushed and the muscular power is increased. In cases of poisoning, the early symptoms, which usually commence within one or two hours of the toadstool being eaten, closely resemble the above; the patient may become actually maniacal. Sickness and diarrhoea are sometimes present. Convulsions and stupor usually follow, and within a few hours the patient becomes drowsy and goes to sleep, and may awake but little the worse for the accident.

Figure 493.
The Scarlet Fly Cap (*Amanita muscaria*).

A few fatal cases have been recorded, however. In these the stage of stupor is followed by one of collapse, with embarrassed breathing, blueness of the skin, lowered temperature, and death from heart failure within twelve or thirteen hours of the onset of symptoms.

The poisonous principle of the Scarlet Fly Cap is easily dissolved

Figure 494.
The Slayer (*Lactarius rufus*).

out in water. The fungus used to be bruised and steeped in milk, and the milk used for killing flies. Chemists have isolated an alkaloid, muscarine, from it as a clear, syrupy liquid. This substance is very poisonous to animals. It slows the heart and increases secretions, acting in most respects in exactly the opposite way to atropine, the poisonous principle of the Deadly Nightshade (*Atropa belladonna*), and when the heart of an animal has almost ceased to beat through muscarine it may be stimulated to strong action by the use of atropine. But muscarine is not the only poison in the Scarlet Fly Cap, for specimens from which the muscarine has been extracted still give rise to symptoms of poisoning analagous to those which arise in an animal poisoned by the Scarlet Fly Cap and treated by atropine. There is also present in the fungus a second alkaloid, called by Kobert pilz-atropine, which neutralises to a greater or less extent the effects of muscarine. It is very likely that in those parts of France and Russia where *Amanita muscaria* is used for food, the amount of pilz-atropine present in the fungus is relatively large.

The Panther Cap (*Amanita pantherina*) and the Sorceress (*Amanita mappa*) are both poisonous, and give rise to similar symptoms to the Scarlet Fly Cap (*Amanita muscaria*).

Entoloma sinuatum and *E. fertilis*, toadstools with pink spores, nearly poisoned Mr. Worthington Smith, the botanist.

Liberty Cap (*Psilocybe semilanceata*) a small toadstool with a conical yellow cap, dark gills, and a long stalk, commonly found on dung (see Figure 492), appears to have poisoned children on two separate occasions.

The Skull Cap (*Stropharia semi-globata*) a somewhat similar form, also growing on dung, but with a rather larger and more rounded cap and more or less of a ring round the stem, is stated by Sowerby to have proved fatal.

Probably most of the *Russulae* and those species of *Lactarius* with white milk (the edible *Lactarius deliciosus* has red milk) are dangerous. The Emetic Russule (*Russula emetica*) with its bright red cap, the Burning Lactar (*Lactarius pyrogalus*), the Slayer (*Lactarius rufus*, Figure 494), the Fringed Lactar (*Lactarius torminosus*) should especially be avoided. While a good many cases of poisoning from species of *Russula* and *Lactarius* have occurred, none seem to have proved fatal. Within half an hour to an hour vomiting and diarrhoea, thirst and abdominal pains supervene, and are generally followed by giddiness, convulsions and a semi-conscious drunken condition.

FIGURE 497.
Helvella crispa.

FIGURE 496.
The Common Morel
(*Morchella esculenta*).

FIGURE 495.
The Pill Sprout (*Panus stypticus*).

The Pill Sprout (*Panus stypticus*), a small dark brown form with the stem to one side, common on rotting wood (see Figure 495), is said to act as a violent purgative.

The Satanic Boletus (*Boletus satanus*), a large toadstool with a buff cap and bright red pores below it, has proved fatal. It acts as a violent irritant poison when eaten raw or cooked, and causes sickness with bloodstained vomit and diarrhoea with the passage of blood: convulsions and collapse are also present in severe cases. *Boletus luridus* is described as poisonous by some writers and as harmless by others.

The Common Morel (*Morchella esculenta*, Figure 496), has at times given rise to symptoms of poisoning and even proved fatal. Vomiting, depression, cramps, delirium, jaundice and collapse were the chief symptoms.

Helvellas (see Figure 497) are much eaten in France, Germany and Russia; but sometimes cause fatal poisoning. The poison, Helvellic acid, is only present in mature specimens and is easily dissolved out in water. If Helvellas are boiled, squeezed, and dried they are harmless, but the water they were boiled in, though pleasant to the taste, is very poisonous. Dogs drink it readily but are poisoned by it. The principal symptoms produced are sickness and diarrhoea, jaundice, irregular breathing, delirium and convulsions.

The recognition of cases of toadstool poisoning is generally easy; but it is much more difficult, as a rule, to say which toadstool has been taken. A rapid onset of symptoms with drunkenness and delirium strongly suggest the Scarlet Fly Cap (*Amanita muscaria*). An examination of the remains of the meal or of the vomit is of great assistance. The flesh of the Death-cup (*Amanita phalloides*) is seen microscopically to contain large sausage-shaped cells among the smaller threads of the mycelium, and this structure can still be made out even after the toadstool is cooked. The appearance of the spores of several species, notably *Amanita muscaria* and *A. phalloides* and *Russula emetica*, under the microscope, is very characteristic, and, as these structures resist digestion, a diagnosis may sometimes be made by this means.

A word or two on the treatment of toadstool poisoning may not be entirely out of place. The first thing to do is, of course, to endeavour to clear the digestive tract of the poison. Vomiting should be encouraged or artificially produced by mustard and water or other emetics and the stomach may be washed out if this is practicable. Unless there is severe diarrhoea, purgatives should be given. A tea-spoonful of castor oil with one or two drops of croton oil in it has proved most effective. Powdered charcoal (animal or vegetable) should also be administered. Where the toadstool contains Muscarine (*Amanita muscaria*, *A. pantherina* or *A. mappa*) one-hundredth to one-fiftieth of a grain of atropine should be injected hypodermically. In other cases opium or morphia will be useful, both for the intestinal irritation and for the nervous symptoms. Where severe diarrhoea has caused depletion of the tissues of their fluid contents, transfusion with salt solution may be desirable.

FIGURE 498.
Shaggy Caps (*Coprinus comatus*).

Turning now to the general composition of fungi, we find that seventy to ninety-two per cent. is water. Of the dry solids two to five per cent. consist of nitrogen. This is a high percentage, but only one to 3·5 per cent. is combined as proteid. The percentage of mineral salts is high, six to twelve per cent., and these are mainly of potassium with some iron and manganese. There is also in the dried toadstool 1·5 to six per cent. of fats, fatty acids and other substances soluble in ether, the food value of which is doubtful. The remainder is largely carbohydrates, such as cellulose, fungus cellulose, glycogen and mannite. Fungi contain no starch.

The relatively-high percentage of nitrogen would suggest that fungi should have a high nutritive value,

FIGURE 499.
The Common Earth-ball (*Scleroderma vulgare*).

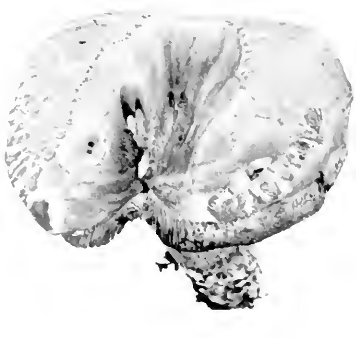

FIGURE 500. *Boletus chrysenteron*.
Showing tooth marks of squirrel which had nibbled the toadstool.

but only part of this is combined as proteid and a much smaller part as digestible proteid. Only one-seventh part of the nitrogen contained in Shaggy Caps (*Coprinus comatus*, Figure 498) can be digested and made use of by the human body. Of all the toadstools, the common mushroom (*Psalliota campestris*) is believed to contain the highest percentage of digestible proteid; yet this is really so small that it is only one forty-seventh of that in beef and one fifty-sixth of that in beans, while it is just about equalled by the proteid contents of cabbage and potatoes. Continuing our comparison with these two vegetables we find that the percentage of fat in mushrooms is about the same as in cabbage, but a little more than in potato, while the carbohydrates, though approximately the same in amount as in cabbage, are only a quarter as abundant as in potato. Clearly, then, from the point of view of actual nourishment, we do just as well on cabbage as on any toadstool, and run much less risk.

But the value of any food is not to be measured entirely by the percentage of digestible proteids, carbohydrates and fats that it contains. Many substances having no food value are of use as stimulants to digestion and aids to assimilation. Their action is in part psychological; for there is no doubt that pleasant flavours and aromas stimulate the movements of the stomach and the secretion of the digestive juices.

The conclusion we must come to is, therefore, that certain varieties of toadstool properly cooked are not undesirable constituents of a meal, but that except in the case of a few kinds, like the common mushroom, they are by no means free from risk. There is no rule to distinguish an edible from a poisonous variety. Dependence on some supposed rule has been responsible for a large proportion of the cases of poisoning. The only way is to get to know each edible species, with all its distinguishing characteristics, and to eat no toadstool that does not conform with these in every particular.

Lastly, of what value are the edible and poisonous properties of toadstools to the toadstool plant? There can be no doubt but that the truffles which are found beneath the soil, and are sought for and rooted up and eagerly devoured by pigs, really like to be thus treated; for by this means the spores are distributed in a manner most suitable for their germination. The truffles, with their myriads of contained spores, are the fruits of the truffle plant, and their strong scent is as surely designed to make their presence evident to pigs as are the bright colours of many fruits to make them noticeable to birds. The Common Earth Ball (*Scleroderma vulgare*, Figure 499), a variety of puff ball that has a very thick covering which never spontaneously ruptures, is commonly found perforated in various directions by beetles. No doubt these creatures nibble through the outer covering for what they can get inside, but by so doing they clearly assist in the distribution of the spores.

Many species of toadstool, including the deadly Death-cup, are found eaten by slugs, and a friend once told me that she had watched a squirrel for several minutes nibbling a species of *Russula* with evident relish. Slugs are, however, rather careful of the variety of fungus that they care to tackle. Experiments with slugs kept without food for a couple of days showed that while the Stump Tuft (*Armillarea mellea*), the Emetic Russule (*Russula emetica*), and the Scarlet Fly Cap (*Amanita muscaria*) were readily eaten, the Sulphur Tuft (*Hypholoma fasciculare*) and the Melon Hygrophorus (*Hygrophorus pratensis*) remained practically untouched. The internal economy of the slug must be very different from our own, for some of those species preferred by the slug are to us deadly poisonous. It will be seen from the above that several of the bright-coloured species are eaten in nature and one is inclined to wonder whether the bright colours have any value for attractive purposes. That the brilliant tints of so many fungi are due to no mere accident, and are something more than a method for the disposal of material of no further value to the plant, is indicated by their constant presence in certain species, and by their limitation in nearly every case to that part of the toadstool visible from above, and perhaps most of all by the coloured substance in most cases being found only in a very thin layer of tissue on the upper surface of the cap.

Nevertheless, as will be seen above, a good many species, and among them some of the bright coloured, are rarely, if ever, eaten in nature, and moreover, the umbrella-like form which has proved so successful in the struggle for existence that it is found in many thousands of different species of toadstool, is so excellently adapted for the distribution of the light spores by the wind that it is difficult to imagine that it has been evolved for any other purpose. I would suggest, therefore, that the bright colours of toadstools are for the purpose of making them conspicuous so that they may be avoided and neither trodden on nor eaten by mistake by grazing animals. The fact that many species of black spored toadstools, *Coprinus*, *Panœolus*, *Stropharia* and *Galera* are found almost exclusively on the dung of various herbivora, and that the spores of other fungi have been shown to have been present in the alimentary canal of rabbits, must be only taken to indicate that the spores are able to traverse the digestive tract unharmed, and does not show that fungi are ever eaten by these animals. It is much more likely that the numerous and minute spores have settled on some of the regular food of the animal, and have then been swallowed by accident with it.

But toadstools, especially the gills of those kinds that possess them, are very frequently eaten by slugs, and the observations of Voglino tend to show that this is not altogether disadvantageous to the fungus plant; for the germinating spores of species of *Russula* and *Lactarius* were found in the digestive tracts of slugs fed on these toadstools. Further, the spores of other species that would not germinate on ordinary culture media were found to do so readily in the fluid from the digestive tract of the slug. Slugs are eaten by many birds who often fly long distances, and it is possible that in this way the wide distribution of some species of fungus is to be explained. The germinating spores of species of *Lactarius* and *Russula* have been actually found in the digestive tracts of toads caught in pine woods, and were probably derived from the slugs that they had eaten.

Perhaps the most striking of Voglino's observations was the following. Ten specimens of a toadstool (*Hebeloma fastibile*) were enclosed as they grew and four starved slugs introduced. The toadstools were eaten, especially their gills. One of the slugs was killed and germinating spores of *Hebeloma fastibile* found in its digestive tract. The other three were left in the enclosure, which was watered with sterilised water, and kept enclosed for nearly a year. Specimens of *Hebeloma* were then found to be more numerous within it than elsewhere in the neighbourhood.

It is probable, therefore, that several species of *Lactarius* and *Russula* are greatly assisted by slugs in their spore dispersal.

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SOLAR DISTURBANCES DURING OCTOBER, 1912.

By FRANK C. DENNETT.

ALTHOUGH the sun was observed every day during October, with the exception of the 26th, only two days (15th and 25th) were marked as being without visible disturbance. Spots were observed on nine days, and faculae on the remaining nineteen. The longitude of the central meridian, at noon on October 1st, was 138° 57'.

No. 20.—First seen as a group on the morning of October 5th, but an area near by had shown signs of activity since the 1st, developing minute pores on the 3rd. Upon the 5th the preceding and following spotlets were largest, the former increasing considerably by the 6th. On the 7th when one of the smaller spots had a decidedly vortical appearance, the leader had become 11,000 miles in diameter, and the trailer 15,000 miles. The group was decidedly of an elliptical form. Rapid changes were frequently taking place. On and after the 6th the leader had its penumbra brightening inwards, and the hindermost spot also on the 9th. On the 10th the components had much decreased in size, and next day only one spot, the leader, was visible amid the faculae closing up to the western limb. The outbreak occurred directly south of the place of No. 18.

No. 21. On the 18th a faculic knot was noted within the eastern limb. Next day closely north-west of this was a penumbraless pore, also surrounded by a facula. The latter was visible on the 20th, but the pore was gone.

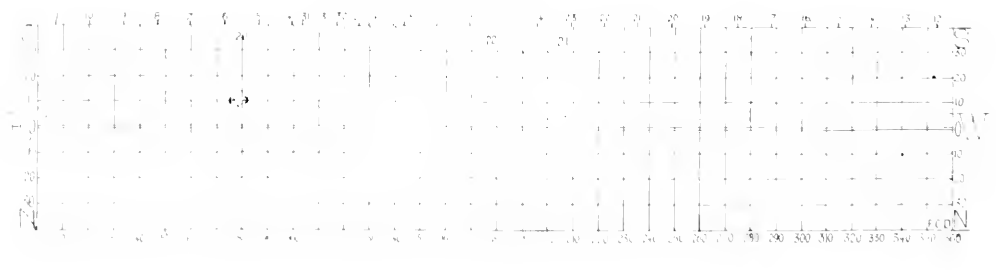
No. 22. Amid the faculic remains of No. 19, a pore, only lasting one day, was visible on the 29th.

In other ways the photosphere has shown traces of activity, small dusky pores showing, yet not sufficiently well marked for measurement. Particularly was this the case on the 25th, when long serpentine chains of these dusky dots were visible. Also on the 28th in low southern latitude, some three days within the east limb, there was a close group of dull spots, easily seen with the spectroscope, but not so with the telescope.

The faculic disturbances set down on the chart were observed as follows:—That around Longitude 2°, S. Latitude 5°, from October 6th to 8th and on the 16th and 17th; the knot at 1°, 17° N., on the 17th; that on either side of 50°, 2° S., on the 3rd and 4th; that crossing 60°, at 7° S., on the 10th until the 13th and on the 29th; the knot at 125°, 21° S. on the 24th; that at 140°, 20° N. on the 23rd and 24th; the considerable group about 172°, 12° S. from the 3rd to the 5th, and also on the 30th and 31st; that in the same longitude, but in 5° S. Latitude, from the 20th till the 23rd; and that at 200°, 4° S. from the 18th until the 20th.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock, C. P. Frooms, D. Booth, and the writer.

DAY OF OCTOBER, 1912.



THE FACE OF THE SKY FOR JANUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun R.A.	Sun Dec.	[illegible] R.A.	[illegible] Dec.	Mercury R.A.	Mercury Dec.	[illegible] R.A.	[illegible] Dec.	[illegible] R.A.	[illegible] Dec.	Neptune R.A.	Neptune Dec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 51.

Date.	Sun. P	Sun. B	Sun. L	M[illegible] P	Saturn P	Saturn B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 52.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN has commenced his Northward march. Sunrise during January changes from 8-8 to 7-44; sunset from 3-58 to 4-43. Its semi-diameter diminishes from 16′ 18″ to 16′ 15″. Nearest Earth, January 1st, distance 91¼ million miles.

MERCURY is a morning star. It passed greatest elongation 22° 4 W. December 28th. Illumination, January 1st seven-tenths, January 31st twenty-nine thirtieths.

VENUS is an evening Star, approaching its greatest elongation, which it reaches on February 12th. Illumination two-thirds, semi-diameter 10″.

THE MOON.—New 7^d 10^h 28^m*m*; First Quarter 15^d 4^h 2^m*e*; Full 22^d 3^h 40^m*e*; Last Quarter 29^d 7^h 34^m*m*. Apogee 11^d 1^h*m*, semi-diameter 14′ 44″; Perigee 23^d 11^h*m*, semi-diameter 16′ 45″. Maximum Librations, 1^d 6 W., 6^d 7 N., 17^d 8 E., 20^d 7 S., 29^d 7 W., February 2nd 7 N. The letters indicate the region of the Moon's limb brought into view by libration. E, W. are with reference to our sky, not as they would appear to an observer on the Moon.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913			h. m.		h. m.	
Jan. 9	φ Capricorni	5·3	5 44 *e*	67		
,, 11	70 Aquarii	6·1	7 35 *e*	58		—
,, 12	BD 6 6220	7·0	6 2 *e*	37		
,, 14	BAC 270	6·0	9 10 *e*	25		
,, 16	27 Arietis	6·4	6 13 *e*	350	6 40 *e*	314
,, 17	ζ Arietis	4·8	3 23 *e*	63	4 30 *e*	241
,, 17	BAC 1055	6·0	6 5 *e*	88		
,, 18	χ Tauri	5·3	6 5 *e*	85	10 10 *e*	250
,, 20	BAC 1740	6·5	1 58 *m*	100	2 54 *m*	262
,, 20	49 Aurigae	5·1	10 37 *e*	60	11 35 *e*	313
,, 21	ε Geminorum	5·5	11 22 *e*	103	0 32 *m**	201
,, 24	26 Leonis	7·0			4 47 *m*	25
,, 26	BD −3 2530	7·0	—		1 40 *m*	300
,, 27	BAC 4220	7·1	—		0 2 *m*	305
,, 28	Spica	1·2	1 3 *m*	117	2 8 *m*	314
,, 31	BAC 5347	5·5	4 14 *m*	151	5 11 *m*	250

TABLE 53. Occultations of stars by the Moon visible at Greenwich.

The asterisk indicates the day following that given in the date column.

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

Special attention is called to the occultation of the first magnitude star Spica, or Alpha Virginis, on the morning of Jan. 28th. The Moon will be rather low at Disappearance, but the conditions at Reappearance are pretty favourable.

MARS is a morning Star, but is too far south to be in table.

JUPITER is still practically invisible, having been in conjunction with the Sun on December 20th.

SATURN is an evening Star, 6° South of the Pleiades. Polar semi-diameter 9″. The major axis of the ring is 45½″, the minor axis 18½″. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). January 3^d 1^h·5 *m*, 10^d 4^h·7 *e*, 18^d 3^h·0 *m*, 25^d 5^h·2 *e*, February 2^d 0^h·4 *m*. Dione (every third given). January 3^d 11^h·6 *m*, 11^d 4^h·6 *e*, 19^d 9^h·6 *e*, 28^d 2^h·7 *m*.

Rhea (every second given). January 5^d 0^h·4 *e*, 14^d 1^h·1 *e*, 23^d 1^h·9 *e*, February 1^d 2^h·8 *e*.

For Titan and Iapetus, E. W. mean East and West elongations, I. S. Inferior and Superior Conjunction, Inferior being to the North, Superior to the South. Titan, 2^d 8^h·4 *e* I., 6^d 4^h·0 *e* W., 10^d 2^h·6 *e* S., 14^d 5^h·8 *e* E., 18^d 6^h·1 *e* I., 22^d 2^h·2 *e* W., 26^d 0^h·9 *e* S., 30^d 4^h·3 *e* E. Iapetus 9^d 8^h·2 *e* S., 30^d 3^h·6 *m* I.

URANUS is invisible, being in conjunction with the Sun on the 24th.

NEPTUNE is in opposition on the 14th. It enters the map of small stars which was given in "KNOWLEDGE" for December, 1911, page 476.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant.		Remarks.
	R.A.	Dec.	
Jan. 2–3	230	+53	Brilliant shower, swift; long paths.
,, 3	156	41	Swift.
,, 11–25	220	+13	Swift, streaks.
,, 17	205	53	Slow, bright.
,, 17–23	150	27	Swift.
,, 25	131	32	Swift.
,, 29	213	+52	Very swift.

DOUBLE STARS AND CLUSTERS. The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS. Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 4^h to 8^h, next month 6^h to 10^h, and so on. In the case of Algol variables, the time of one minimum is given where possible, and the period. Algol, owing to its brightness, will be given for wider limits.

Star	Right Ascension.		Declination.	Magnitudes.	Period.			Date of Minimum.		
	h	m.			d.	h	m.	d.	h.	m.
Algol	3	2	40·6	2·3 to 3·4	2	20	49	Jan. 2	5	28 *m*
RV Persei	4	5	34·0	9·5 to 12	1	23	22			
RW Persei	4	14	42·1	8·5 to 11	13	4	51			
RS Cephei ...	4	50	80·1	9·5 to 12	12	10	5			
TT Aurigae	5	3	39·5	7·5 to 8·5	0	16	0	Jan. 2	2	6 *m*
RY Aurigae	5	12	38·2	10·5 to 12	2	17	25			
RZ Aurigae ...	5	44	31·6	9·5 to 12·5	3	0	15			
SV Tauri	5	47	28·1	9·5 to 12	2	4	0			
SX Geminorum	5	55	24·5	9·5 to 11	4	0	10			
RW Geminorum ...	5	56	+23·1	9·5 to 11	2	20	46			
RW Monocerotis	6	30	8·0	9 to 10·5	1	21	45			
RX Geminorum	6	44	33·3	8·5 to 9·5	12	5	0			
RU Monocerotis	6	50	7·5	9·5 to 10·5	0	21	30			
R Canis Maj.	7	15	16·2	6·0 to 6·5	1	3	16	Jan. 1	0	6 *e*
RY Geminorum	7	22	15·8	8·5 to 10·5	9	7	13			
Y Camelop ...	7	20	76·3	9·5 to 12	3	7	20			
RR Puppis	7	44	41·2	9·5 to 10·5	6	10	19			
V Puppis	7	56	49·0	4 to 5	1	10	54	Jan 4	0	48 *m*

TABLE 54.

Of long period variables *o* Ceti (Mira) will reach a maximum at the end of April, when it will be invisible in the sunshine, but it may be seen brightening early in the year.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

POSSIBLE SCREENING ACTION OF MATTER ON GRAVITATION.—An article by Professor de Sitter in *The Observatory* for November describes some recent researches both by him and Herr Bottlinger, of Munich, as to whether any traces can be detected of diminution of the sun's attraction on the moon during the times when she is immersed in the earth's shadow. They both independently found that some hitherto unexplained oscillations in her motion, which were brought to light by Professor Newcomb's analysis of the observations, could be explained on this hypothesis; and, further, there were some prospects that the large oscillation with a period of some three centuries, which has hitherto baffled all the efforts of lunar theorists to find an explanation, might likewise be due to the same action. This last is still only a conjecture, but the suggestion seems worthy of further research. The suggestion is by no means a new one; it was the basis of Le Sage's explanation of gravity by "Ultramundane corpuscles." These were supposed to be tiny atoms flying through all space with immense speed, and penetrating the interior of all bodies, meeting, however, some obstruction in doing so; thus two neighbouring bodies would screen each other to some extent, and each would have a greater bombardment on the side away from the other, so that there would be a resultant force pushing the bodies together.

If the theory is true, many of the fundamental constants of astronomy will need some modification. For example, the nearer portions of an attracting body like the sun will screen the more distant portions, so that the attraction of the latter will be diminished, and its real mass would be somewhat greater than that assumed; also a sphere would no longer attract as though its mass were concentrated at its centre, The effect of this would be more in evidence the nearer the attracted body was to the sun; it seems possible that the anomalous motion of the perihelion of Mercury might thus be explained. It will, of course, be understood that the screening action must be extremely slight, and any effects can only be detected by the greatest care both in calculation and observation.

COMETS.—In addition to Gale's comet, mentioned last month, two others have been discovered. The first, found by M. Schaumasse at Nice, proved to be Tuttle's comet, which had returned two months earlier than was expected. No one had computed the perturbations for this revolution, and M. Fayet has since found that the action of Jupiter in 1901, when there was a pretty near approach of the comet to it, will fully explain the change of period. This has been the shortest revolution of the comet since it was first seen, in 1790, and it is curious that the last revolution of Halley's comet was also a shortest on record. The period of this comet is thirteen and a half years, and six revolutions do not differ much from seven of Jupiter, so that the perturbations repeat themselves, and there is a wave in the periodic times, similar to the one I showed for Encke's comet some time ago.

Years of Perihelion	Julian Day of Perihelion	Interval	Instantaneous Period at Perihelion
1790.........	2374874·89		$5060^d·37$
1803.........	2379902·27	$5027^d·38$	5017 ·03
1817.........	2384843·78	4941 ·51	4940 ·52
1830.........	2389793·63	4949 ·85	4961 ·51
1844.........	2394747·96	4954 ·33	4977 ·31
1858.........	2399734·54	4986 ·58	5020 ·12
1871.........	2404763·80	5029 ·26	5047 ·06
1885.........	2409796·15	5032 ·35	5023 ·89
1899.........	2414779·52	4983 ·37	4991 ·85
1912.........	2419704·41	4924 ·89	4912 ·(?)

The following table gives the elements of Tuttle's Comet by MM. Fayet and Schaumasse, and of Borrelly's Comet (c 1912) by Dr Kobold:—

	Tuttle.	Borrelly.
T	1912, Oct. 28·4106 Paris M.T.	1912, Oct. 21·95 G.M.T.
ω	206° 51′ 29″	101° 31′
☊	269 33 57	144 53
i	55 0 24	124 9
log q	0·01191	0·0457
e	0·8183†	

Tuttle's Comet will be too far south for European observation in December.

Borrelly's Comet will be in R.A. $19^h\ 58^m$, N. Dec. 3° 14′ on December 1st; daily motion $+2^m\ 24^s$, South 45′. It will be of the tenth magnitude.

Gale's Comet may still be seen in the telescope.

Place on December 4th, R.A. $16^h\ 34^m\ 55^s$, N. Dec. 46° 56′.
" " " 8th, R.A. $16^h\ 40^m\ 25^s$, N. Dec. 49° 50′.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

BOTANY AT THE BRITISH ASSOCIATION.—The Presidential Address given by Professor Keeble to Section K (Botany) was exactly what might have been expected from one who has shown in his publications how even the most specialised of subjects may be made intelligible and fascinatingly readable to the non-specialist, if presented in that lucid style which is either a happy knack or the outcome of an infinite capacity for taking pains. Professor Keeble's introductory remarks were both witty and wise. He began by comparing himself with Autolycus, as one who had worked on the border lines of several biological sciences, though readers of his wonderful little book "Plant-animals" would certainly not be inclined to consider the results of its author's brilliant investigations as "unconsidered trifles." After discussing the merits and drawbacks of the general and special methods for a presidential address, the President compared the specialisation of science in our times with the versatility of the great Victorian naturalists, and passed some searching criticisms on our methods of University teaching in science.

ANIMAL PARASITES OF PITCHER-PLANTS.—Jensen (*Ann. jard. bot. Buitenzorg*, Suppl. 3, Part 2) has described an interesting case of symbiosis or parasitism, analogous to the presence of intestinal parasites in animals, in the pitchers of *Nepenthes*. These pitchers are, as is well known, filled with fluid containing ferments in which dead insects are digested, but Jensen has found that several species of fly larvae develop normally in this fluid. So abundant are they that the author found them in every one of the hundreds of pitchers he examined during several successive years in Java. These dipterous larvae were reared, and six of the seven discovered in this curious habitat were found to be new species, belonging to three different families of Diptera. One of the most remarkable characters of these larvae is their power of "anti-fermentation," which appears to retard the action of the ferments in the fluid filling the pitchers. This retarding action was definitely proved by experiments, the larvae being placed in solutions of pepsin and pancreatin. Closely related larvae taken from neighbouring pools were unable to live in the pitchers, hence the anti-ferment is to be regarded as an adaptation to this symbiotic mode of life.

ORCHIDS AND THEIR FUNGUS-GUESTS.—The roots of various orchids contain a helpful fungus which enables them to absorb food from decaying humus. Bernard (*Ann. Sci. Nat., Bot.*, IX., 14) has shown that small portions cut from the bulbous parts of some orchids appear to have a poisonous effect on the root-inhabiting fungus or mycorhiza of the same plants. In cultures the fluid diffusing from the bulb material killed the threads of the fungus. When heated to 55° C. the toxic properties of the bulb are destroyed, and this with other data leads to the conclusion that the substance acting as a fungicide is a ferment (enzyme). It serves to explain the fact that no endophytic fungi are found in the bulbous portions of various orchids which contain fungus in their roots, and also confirms Bernard's view that these orchids tolerate the mycorhiza, though well able to defend themselves against its complete invasion of their tissues.

CHEMISTRY.

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

EFFECTS OF STERILISING SOIL.—A series of instructive investigations upon the sterilisation of soil by means of steam has recently been published. The principal chemical changes that take place when the soil is subjected to the action of steam under pressure are described by Messrs. Lathrop and Schreiner, in *The Journal of the American Chemical Society* (1912, XXXIV, 1242). From their experiments it appears that the proportion of substances soluble in water is increased by the process, while the acidity of the soil is also increased, even though ammonia and allied compounds are simultaneously produced. Most of the organic compounds that have been isolated from ordinary soil also show an increase after the steaming, nucleic acid being an exception.

Products of the decomposition of nucleic acid and proteins which are favourable to the growth of plants are formed in the steaming process; but there is also a simultaneous

* At these returns the comet was not seen: the values are calculated by Clausen.

† I have corrected this value to correspond with the actual period of the comet: the authors gave 0·8055.

production of injurious compound [illegible] dihydroxy stearic acid.

Comparative experiments [illegible] heated and unheated soil showed that poorer growth [illegible] obtained with the former, and from this the inference [illegible] that the production of injurious substances [illegible] that of the beneficial compounds, and that [illegible] former are eliminated it is not possible to ascertain to what extent steaming may be beneficial.

Conclusions of a similar character are drawn by Messrs. Lyon & Bizzell in a paper communicated to the Eighth International Congress of Applied Chemistry (*Original Communications*, 1912, XV, 159), in which the results of inoculating steamed soil with fresh and with heated soil are described.

At first the best growth of plants was obtained on soil that had been inoculated with fresh soil, but this did not continue. The luxuriance of growth appeared to depend not so much upon the available nutritive substances present as upon the amount of toxic compounds produced by the steaming, and this factor varied with the nature of the organic substance in the original soil. Aeration of the soil and the growth of plants both reduced the toxic character of the steamed soil but the speed of oxidation was not always a measure of the rate at which the soil ceased to be toxic.

GEOLOGY.

By G. W. Tyrrell, A.R.C.Sc., F.G.S.

STRATIGRAPHY AT THE BRITISH ASSOCIATION.—As might have been expected, Scottish stratigraphy bulked largely at the Dundee meeting. Two important announcements were made of the discovery of fossils in the hitherto barren Highland Border Series. This is a narrow band of crushed shales, cherts, grits, and calcareous beds, occasionally with igneous rocks, occurring at intervals along the Highland Border fault from Arran on the West to Stonehaven on the East Coast of Scotland. The fossils have been discovered by Dr. T. J. Jehu near Aberfoyle, and by Dr. R. Campbell at Craigeven Bay, near Stonehaven. In the Aberfoyle district, between Loch Lomond and Callander, the Border Series is separated by a line of thrust from the Leny Grits (Dalradian) to the north, and by a reversed fault from the Lower Old Red Sandstone to the south. The fossils have been found in muddy films in grey chert bands, one to three inches thick, and consist, as determined by Dr. B. N. Peach, almost entirely of hingeless brachiopods belonging to the following genera: *Acrotreta*, sp.; *Lingulella*, sp.; ? *Obolus*, sp.; *Obolella*, sp.; and flattened chaetae of Polychaete worms. This assemblage indicates that the series is probably of Upper Cambrian age.

The Border Series near Stonehaven consists of crushed spilitic lavas with intercalated black shales, jaspers and cherts. In August, 1909, Dr. Campbell, with Drs. Peach and Gordon, succeeded in finding fossils in the black shales. Mr. Tait, of the Geological Survey of Scotland, subsequently made a detailed search in the fossiliferous beds, and the material obtained by him, submitted to Dr. Peach for determination, yielded the following forms: *Lingulella*, *Obolella*, *Acrotreta*, *Linarssonia*, *Siphonotreta*; a bivalve phyllocarid allied to *Caryocaris* and *Lingulocaris*; and cases of a tubicolar worm. Since graptolites are absent from this assemblage, Dr. Peach believes that it indicates an Upper Cambrian, rather than an Ordovician age. The Border Series is here separated from the Dalradians by a reversed fault, and is overlain unconformably by strata of Downtonian age.

Dr. R. Campbell also described his recent researches in the Downtonian and Old Red Sandstone of Kincardineshire. The rocks now assigned to the Downtonian are a series of vertical or highly-inclined strata, three thousand feet thick, consisting of breccias, mudstones, shales, volcanic conglomerates and tuffs. [illegible] strata have yielded *Dictyocaris* in abundance, also *Ceratiocaris*; *Archidesmus*, sp.; a new genus of Myriapod; *Eurypterus*, sp., nov.; and plates of a new *Cyathaspis*. The volcanic conglomerates indicate that the volcanic activity destined to play so large a part in the history of the succeeding Old Red Sandstone, had already been initiated in Upper Silurian times.

The highest beds of the Downtonian pass up conformably into the micaceous sandstones and conglomerates of Stonehaven, which are considered as the base of the Lower Old Red Sandstone in this area. The latter consists of a great thickness of coarse conglomerates and sandstones, with lavas and tuffs. The recognition of certain well-marked volcanic zones has been of assistance in working out the stratigraphy. The lavas include dacite, hornblende-biotite-andesite, augite-andesite, hypersthene-andesite, hypersthene-basalt, and olivine-basalt. Minor intrusions occur in the form of dykes and sills of quartz-porphyry, biotite-porphyry, dolerite, and lamprophyre. The coarse conglomerates which form so large a part of the succession may be divided into two groups; those built largely of quartzites and other Highland rocks; and those consisting mainly of volcanic rocks — the volcanic conglomerates.

Further excavations among the Cambrian rocks of Comley, Shropshire, are described by E. S. Cobbold. These have disclosed green sandstones of Lower Cambrian age in Comley brook, in which fossils characteristic of the *Olenellus* limestone of the district have been found. A Middle Cambrian breccia has also been discovered largely composed of debris of the above-mentioned sandstone, but the matrix of the breccia has yielded a *Paradoxides* fauna new to the district.

MICROSCOPY.

By F.R.M.S.

NOTE ON PREPARING FLIES' TONGUES FOR THE MICROSCOPE.—The short-horned Diptera possess a singularly beautiful organ in their tongue or proboscis—either appellation is justifiable—produced by the fusion of two lateral maxillae. The chitinous cuticle or skin is studded with numerous sclerites or hard pieces, usually of a dark brown colour; and these sclerites occur in several series, some constituting supports for the organ, some the bases of the sucking pad on each side, and some the C-shaped supports for the canals which traverse its under surface. The transition from one of these series to another is not abrupt; the accompanying figures show the passing of the basal sclerites into those of the canals. In a typical fly there are three series of basal sclerites, central, anterior, and posterolateral. The central ones are in many species partly modified into the organs which have been described in the pages of *Science Gossip* as "Flies' Teeth"; these alternate with sclerites supporting the junctions of the canals. The terminal canals frequently give off secondary canals, and therefore are distinguished as anterior and posterolateral. These may be well seen in Mr. Senior's excellent photograph, Figure 270 in our June number. In the picture of *Calliphora vomitoria* (see Figure 501), the four broader black bands at the base represent the "teeth," though their free extremities, shaped like chisels with a triangle taken out of the edge, are not here in focus. In many genera, though not in all, there are several rows of these teeth, placed one behind the other. Internally they have muscles attached to them; and it may be remarked that two kinds of striated muscle are to be found in the proboscis of most flies; the arrangement of the musculature being very complex. Its main attachments are to the posterior transverse median sclerite, its accessory, the posterior lateral, and the inferior basal; these will be noticed as prominent black marks crossing the suctorial surface in Figure 270. It is necessary to give names to these pieces of chitin, as they occur with great regularity in the different groups of flies, sometimes one, and sometimes another, being especially developed or reduced. In *Dolichopus*, for example, the central basal sclerites are fused, and the anterior and posterolateral ones are missing, so that there are no secondary canals; the posterior lateral sclerite is very large, and there are only six or seven canals, each with a very few supporting sclerites, which have prominent squared ends and very thin curved backs; each of these seems to be in reality compound. So distinct is the type of proboscis that there can be no doubt whether a fly belongs to that group or not; and the same may be said of *Scatophaga*, of the different Syrphids, and probably of any genus of the Brachycera. Dipterists, of course, have other characters to guide them, but these other characters are also concerned with modifications of the chitinous parts, so that the microscope may be of use in supplying additional characters. A good deal may be seen of the working of the proboscis in the living fly; but there are certainly some points in its action not yet clearly made out. The pure microscopist knows the blow-fly's tongue as a test object; but the tongue of the house-fly is really better for this purpose, as the supporting sclerites of the canals are relatively less spirally twisted, and consequently more distinct. Viewed on the open side they look like a row of arrows and croquet mallets placed alternately, side by side; we must imagine the letter C, to which they have been compared above, to have its lower limb split, forming a small V. When one looks over the tongues of a number of different species, a great number of variations on this pattern are found; indeed the canal sclerite of a fly seems to be as characteristic as the spicule of a sponge. We also notice that the type used in the canals of some species is used in the supporting parts of others; and hairs may also be found of such a form and distribution as to suggest that all these objects, even the "teeth," are in reality modified hairs.

It is of some importance to the microscopist to be assured that his test object is of the species named; I have seen the proboscis of *Eristalis* labelled "Tongue of blow-fly"; these Syrphids have the intercostal distances of the canal-supports often less than one micron, so that their resolution forms a test of a different order. In the Cordyluridae the distances are also short, but owing to the flattened form of the sclerites resolution is much easier. The preparation of these organs is not a difficult matter. You may soak the fly's head in caustic potash or other alkali to dissolve the muscles,

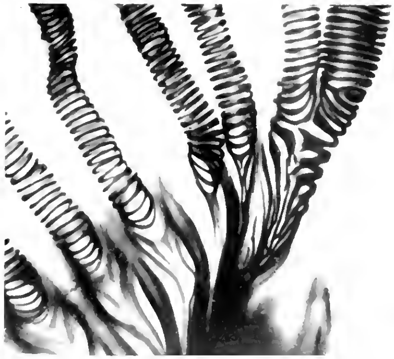


FIGURE 501. *Calliphora vomitoria*, anterior end of central basal region of suctorial pad. The scleritic junction with the anterior basal canal is seen to be composed of twinned sclerites of similar pattern. The bodies of the teeth are seen, though their points are not in focus. It will be observed that the sclerites of the canals simulate a spiral, but are really separate and detached elements. × 300.

FIGURE 502. *Musca domestica*, anterior part of suctorial pad, showing anterior basal row of sclerites of each side, with the secondary canals derived from them. Some of their sclerites are focused for the back of the "C," and appear as transverse lines; others for the open front, showing a varying pattern of angles or curves. In the membrane itself there are a few small circles, looking like the roots of hairs; these appear to have a sensory function. × 300.

afterwards washing it and bringing it into acetic acid for the actual dissection. A much easier plan, which I find more satisfactory, is to take a dried specimen, remove the organ with the point of a pin (this may often be done without damaging the remainder of the fly), and put it into a drop of strong acetic acid, which will soften it in a few minutes or hours as the case may be. Next remove as much of the acetic acid as possible by means of blotting paper, and substitute a drop of good creasote. This will clear and dehydrate, and dissection may be performed in this medium very easily. In order to show the suctorial pad I detach it from the rest of the tongue, so that it is freed from the intrinsic muscles and the external surface with its hairs. This little operation can best be managed by insinuating the point of the needle behind the posterior transverse sclerite. The suctorial surface thus freed consists only of integument, and can be induced to lie flat much more easily. The creasote is then removed and the object mounted flat in a drop of diluted balsam. The integument is pliable so long as it remains in creasote; it stiffens at once in the presence of xylol. Other specimens may advantageously be made, showing the entire organ in different attitudes.

The figures are from photographs taken with Graetzin incandescent gas burner, Kohler lens-system, aplanatic condenser, sixteen millimetres apochromat, and eighteen millimetres compensating ocular, all by Zeiss. Ilford Process plates were used, and Imperial Process developer; the exposure (according to the equation) in the case of Figure 501 was seventy seconds. A longer exposure was tried for the next illustration (Figure 502) at one hundred and twenty seconds, when fine results were obtained, and the thinner and sharper lines thus produced show well in the reproduction. My equation was based upon a large number of experiments made with a more rapid developer; this present one is slower, but gives much more detail, is quite clean in working, and certainly the most useful for this purpose that I have yet tried. The full aperture of the objective was used, the condenser iris being set only to exclude extraneous light.

E. W. BOWELL.

THE ROYAL MICROSCOPICAL SOCIETY.—A conversazione was held at King's College, Strand, on Wednesday, October 16th, the President and Mrs. H. G. Plimmer receiving the guests.

The gathering was an unusually large one, and many of the exhibits were of exceptional interest.

In the Lecture Theatre a cinematograph display of Pond-life was given by Mr. F. J. Spitta, L.R.C.P., F.R.M.S., and this was followed by a lecture entitled "Insects as Carriers of Disease," by Professor R. T. Hewlett, M.D., F.R.M.S., illustrated with lantern slides.

Mr. Max Poser, F.R.M.S., gave a demonstration of "Liquid Crystals," which were shown on the screen, both in the solid and liquid phases, by means of a projection apparatus.

Among the many exhibits in the Large Hall were an Ultra-microscope Photo-micrographic apparatus, shown by Mr. J. E. Barnard, F.R.M.S., and an Abbe Diffraction Microscope; Quartz Mercury Vapour Lamp, by Messrs. J. E. Barnard, F.R.M.S., and Powell Swift. Photomicrographs and slides, showing the interesting "Mitotic Phenomena," were shown by Messrs. F. J. Sheppard and H. F. Angus.

The "Edinger Drawing and Projection Apparatus" was contributed by Mr. J. W. Ogilvy, F.R.M.S., with photographic apparatus, and photo-micrographs by the "Three Colour Process." There were also shown some examples of "Browman Movement" by Dr. G. P. Bate, F.R.M.S.; a complete Optical Bench, by Messrs. R. & J. Beck; Diffraction Experiments, by Mr. J. W. Gordon; Slides and Photographs of Foraminifera, by Messrs. E. Heron-Allen and Arthur Earland, F.R.M.S.; Mycetozoa, by Mr. C. H. Hnish, F.R.M.S.; Trypanosomes, by Professor Minchin, F.R.S.; Stereo-photomicrographs in colour of water-mites, by Mr. H. Taverner, F.R.M.S.; Chemical Reactions, by Professor Herbert Jackson; Micro-spectra Camera, by Mr. Julius Rheinberg, F.R.M.S.; Interference Figures in Crystals, by Mr. Powell Swift; Foraminifera, by Mr. Ernest Heath, F.R.M.S.; An old Microscope, by Professor Dendy, F.R.S.; Photo-micrographic Apparatus and various Slides, by Mr. Chas. Lees Curties, F.R.M.S.; Metallurgical Sections by Mr. Max Poser, F.R.M.S.; and Saccharomycetes by Messrs. A. Chaston Chapman, F.R.M.S. and R. L. Collett.

Another feature arranged by Mr. D. J. Scourfield, F.R.M.S., was a exhibition of Pond-life, due to the combined efforts of Fellows of the Society and to various members of the Quekett Microscopical Club.

THE QUEKETT MICROSCOPICAL CLUB.—On October 22nd, 1912, Messrs. Heron-Allen, F.L.S., F.R.M.S., and A. Earland, F.R.M.S., lectured on "The Foraminifera as World Builders." Reference was made to the "discovery," half-a-century ago, of *Eozoön canadense* in the Laurentian rocks of Canada. Although by general consent *Eozoon* is now relegated to the mineral kingdom, Mr. R. Kirkpatrick has recently announced in *Nature* that he is in possession of fresh evidence of the foraminiferal nature of *Eozoon*, and will shortly publish it. From the point of view of the lecture definite proof of the rhizopodal character of *Eozoon* would be welcome, as it occurs in enormous reefs in Canada and elsewhere. There are at present no definite records of Foraminifera in Pre-Cambrian rocks, but in Cambrian strata we find the group flourishing and already marked by widely separated types. In Silurian times Foraminifera were not numerous, and in the Devonian there is but a single record (by Terquem, at Paffrath in the Eifel). In the Carboniferous, however, Foraminifera begin to be "World Builders," the large arenaceous form, *Saccammina fusuliniformis* McCoy (= *S. Carteri* Brady), being the principal constituent of enormous areas of limestone in Great Britain and on the Continent. In Permian, Permo-Carboniferous, Triassic, Jurassic, and even Cretaceous rocks, while the number of genera and species multiply enormously, they do not form any important proportion of the whole bulk of the formations. With the Tertiary period we reach the Golden Age of the Foraminifera, the age in which they were to reach their maximum development both as regards size and abundance, and to leave their remains in great beds extending across whole continents, and often of enormous thickness. With the passing of the Eocene the Foraminifera lose their all-important position as rock-builders. The genus *Nummulites*, which with *Alveolina* built up enormous areas of limestone extending across Southern Europe to the Himalayas, dies out and dies so completely that at the present day it is represented by only a single small species of rare occurrence in tropical seas. The Miocene and later Tertiary deposits, though often presenting an abundant and extremely varied Foraminiferal fauna, no longer owe their existence to the occurrence of one or few species in enormous numbers.

To-day, the activity of the Foraminifera is displayed in another sphere. In the surface-waters of the great oceans the few genera which are found swarm in countless numbers, and, their dead shells falling constantly to the sea floor, are there building up layers of *Globigerina* ooze over an area, according to Murray and Renard, of more than forty-nine and a half million square miles, exceeding that covered even by the Nummulitic limestone. Of the thickness of the ooze we can form no idea, but as the great oceans are practically permanent it must be very great, because we know from deep-sea deposits which have been elevated into land-surfaces in Malta, Australasia, and elsewhere, that similar deposits have been forming in the deep-sea since at least Miocene times.

PHOTOGRAPHY.

By Edgar Senior.

EXPOSURE TABLE FOR DECEMBER.—The calculations are made with the actinograph for plates of speed 200 H. and D., the subject a near one, and the lens aperture F.16.

Day of the Month	Condition of the Light	Time of Day: 11 a.m. to 1 p.m.	10 a.m. and 2 p.m.	9 a.m. and 3 p.m.
Dec. 1st	Bright	·3 sec.	·4 sec.	·75 sec.
„ „	Dull	·6 „	·8 „	1·5 „
Dec. 15th	Bright	·4 sec.	·5 sec.	1·0 sec.
„ „	Dull	·8 „	1·0 „	2·0 „
Dec. 30th	Bright	·4 sec.	·5 sec.	1·0 sec.
„ „	Dull	·8 „	1·0 „	2·0 „

Remarks.—If the subject be a general open landscape, take half the exposures given here.

PHOTOGRAPHING COLOURED OBJECTS.—It is now generally known even among beginners that in a photograph of a coloured object, taken upon an ordinary plate, the relative value of the colours "as regards their luminosity" are very badly rendered. Blues photograph too light, while yellow and red are reproduced much too dark. The explanation, as is now well-known, lies in the fact that the silver salts employed are far more sensitive to blue and violet than to any other colour, with the result that blue becomes fully exposed almost before any action has taken place from the yellow and red. From the earliest time this was a great source of trouble to the photographer, and Crookes in 1858 suggested the use of a yellow screen, placed in front of the plate, as a means of improving the colour luminosities; but with plates of the low sensitiveness in use at that time such a device was of very little value. With the introduction of the gelatine plate, with its greatly increased speed and general sensitiveness, it was found possible, by employing an extra-rapid plate and a suitable screen, to obtain negatives of coloured objects, in which the luminosities of the colours represented were practically correct. The improvements, however, were at the expense of greatly prolonged exposure. The discovery of the sensitizing action of certain dyes when added to gelatine emulsions at once removed this difficulty, and placed a really practical method at the disposal of photographers. Quite early in the history of photography it had been found possible greatly to modify the sensitiveness of silver salts by the addition of various substances to them; about 1873, Dr. H. W. Vogel found that the addition of aurine to collodion emulsion resulted in an additional light action in the red of the spectrum. Following up this discovery, he finally stated that the addition of certain dyes to an emulsion rendered the silver salts sensitive to the less refrangible rays of the spectrum. The value of eosine as a colour sensitizer was discovered by Waterhouse, in 1875, and in 1879, Ives published his discovery of the orthochromatic effect obtained by the use of collodion emulsion treated with chlorophyll. In 1883, a patent was

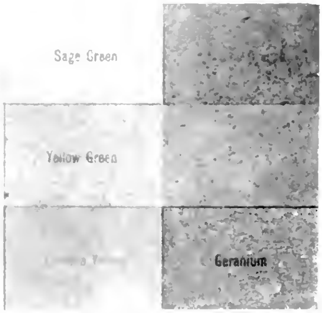


FIGURE 503.

Photograph of the coloured rectangles taken on an ordinary plate.

obtained by Tailer and Clayton, for a method of rendering gelatine emulsion orthochromatic by means of eosine together with ammonia, and plates prepared under this patent were placed upon the market by Messrs. B. J. Edwards & Co., in the following year. Orthochromatic plates, therefore, are those in which a dye or dyes, and sometimes a dye compound with silver, have been added to the sensitive salt, in order to impart sensitiveness towards the brighter colours of the spectrum. The use of such a plate by itself, however, is not found sufficient in practice, as, owing to the still greater

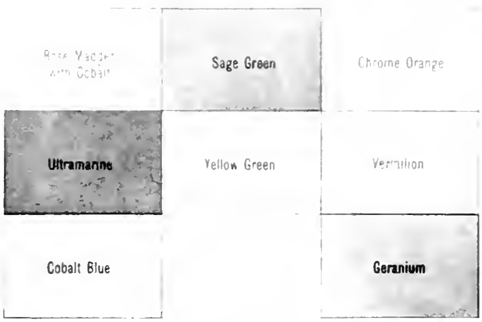


FIGURE 504.

Photograph of the same colours used in Figure 503, but taken on a panchromatic plate.

sensitiveness of the emulsion to blue and violet light, these colours impress themselves too strongly. In order, therefore, to obtain a correct representation in monochrome of the relative luminosities of the various colours in the object photographed, a light filter has to be used to subdue the too active blue and violet rays, as well as to prevent the action of any ultra-violet light. It is also of importance that this light filter should be properly adjusted to the plate intended to be used with it, and that it should not needlessly prolong the exposure. Of late, dyes have become available which not only greatly increase the general sensitiveness of plates treated with them, but especially do so to yellow-light, and to such an extent that it is possible to obtain pronounced orthochromatic effect with much lighter screens, thereby reducing exposure. The great improvement obtained in the rendering of extreme distances, the variety of gradation in foliage, as well as cloud effects upon the same negative, resulting from the use of these plates and suitable filters, are now generally known, and even when employed without a screen, when working late in the evening or on dull days, they will give better results than an ordinary plate. One thing that should be carefully guarded against is "under exposure," as its effects appear to be unduly pronounced with these plates, when employed with a screen. Perhaps one of the difficulties experienced is when to use a screen. This should always be done when a large amount of blue enters into the colour of the subject, such as blue sky with white clouds, distances, and so on, or in photographing landscapes on a dull day, when the greens will be improved by its use. Although the introduction of orthochromatic plates was a great step in advance, still when dealing with objects containing much red they fell far short in giving the desired result, owing to the dyes used not imparting sensitiveness to these colours. During the last year or two plates have been placed upon the market which are practically sensitive to the whole of the visible spectrum, and when used in conjunction with a properly adjusted light filter, will render colours very nearly correct as regards their luminosities when translated into monochrome. In the illustrations are seen two examples from negatives taken of rectangular patches of colour, Figure 503 being from an ordinary plate, while Figure 504 was photographed upon an Ilford Panchromatic plate with a screen. The striking difference between the two is at once apparent and serves to illustrate the great advantage of this class of plate in photographing coloured objects, especially if they contain much red.

ZOOLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

REPRODUCTIVE PERIODS OF BIRDS. It has often been pointed out that the reproductive periods in birds are usually well-defined, and that the sex impulse is precisely punctuated. But A. Chapellier has recently called attention (*Comptes Rendus Soc. Biologie*, LXXII.) to cases of sexual activity outside the breeding season. He instances the autumnal pairing of wild duck, American swallows, "Blue-birds," *Progne subis*, *Elanus dispar*, *Strix perlata*, and *Otus brachyotus*. He asks whether there is not considerable evidence of an autumnal period of sexual excitement among birds, expressed not only in pairing, but in song, attempts at nest-making, and combats.

VIBRATILE FIN OF THE ROCKLING. The three-bearded rockling (*Motella tricirrata*) and the five-bearded rockling (*M. mustela*) are familiar shore fishes—shy, nocturnal, phlegmatic, and non-predaceous. They are fond of lurking under stones between tide-marks, and feed on crustaceans, annelids, starfish, sea-spiders, and the like. Conspicuous on their back is a modified dorsal fin, consisting of a series of small processes, which are almost continuously in rapid vibration, and, anterior to these, a ray which is much longer and thicker than the others, and has much less power of movement. Around the base of the rays there is a groove, and bordering this the skin is kept clear and clean. It has been suggested that this vibratile fin, whose movement is conspicuous (observable from three to six feet in the still water of an aquarium), may serve as some sort of "lure"; but Dr. J. Stuart Thomson brings forward strong evidence pointing in another direction—to the use of the vibratile fin, or the area immediately around it, as a taste organ or food-locating organ. The skin around the groove proves to be very rich in taste-buds, and experiments show that this area is extremely sensitive to the proximity of food. The vibration keeps the "receptor" area clean, and brings to it currents with their subtle indications of available food material.

BIOLOGICAL SCIENCE AND THE PEARLING INDUSTRY.

*A few comments on Dr. Jameson's Paper published in "*KNOWLEDGE*," Vol. XXXV (November, 1912), p. 121.*

By T. H. HAYNES.

THE valuable summary that Dr. Jameson has drawn up of the biological and economic aspects of the pearl and pearl-shell industries may be regarded as the sole publication of the kind existent, and its value is self-evident. It comes at an opportune moment when a Federal Royal Commission is sitting in Australia to inquire into the pearl-shelling industry, and the State Legislatures of Western Australia are discussing a new Pearling Bill that is designed to confer security of tenure upon would-be cultivators, and to establish a fund for promoting the culture of pearl-shell. The motive power behind the Commission and the new Bill is the determination to turn tropical Australia into a white man's country, and the pearling industry, which is the only occupation which employs any substantial number of people, into a white man's industry. It is, therefore, of the highest importance that the information available for the Royal Commission should be of a sound character, so that erroneous ideas and false hopes may not be perpetuated, and I think that through the good offices of "KNOWLEDGE" these aims will be secured.

Dr. Jameson has cleared the air on several important points, viz.:

- The distinction between pearls and "blisters" and the delusion that exists that any progress has been made in the artifical production of pearls.
- The futility of endeavouring to breed pearl-oysters without an enclosure.
- The difference between true cultivation by breeding from parent stock and semi-cultivation by the transplantation of natural-grown young shells to private ground.
- The difficulty of distinguishing between the young of the true pearl-shell and the false "reef" or "bastard" variety.

In my "statement of evidence" which I have sent out to the Royal Commission, I have dealt with these subjects very much in the same way as Dr. Jameson has done, and I have also referred to the friendly controversy which exists between him and myself regarding the 1910-11 experiment at the Montebello Islands. Dr. Jameson disputes my claim to have raised young pearl-shells (*Margaritifera maxima*) from the parent stock in my pond, and I am glad of the ready permission of the Editors of "KNOWLEDGE" to defend my case, and to repeat the arguments which I laid last year before Mr. H. C. Dannevig (the Federal Director of Fisheries in Australia) and have now sent to the Commissioners.

1. In the first place let me say that the amount of water flowing automatically into the pond, on the flood, varies very much according to the state of the tide, rising springs, falling springs and neaps. The result is the main thing. The temperature and salinity remain normal and the parent-stock thrives in a marked manner. So also do young reef-shells.

2. Trial specimens opened for examination showed signs of spatting early in November, the gonads exuding ova or milt when severed by the knife. The bulk of the parent-stock was opened at the end of March, and the exudation was more profuse then than in November and December, but shells from the open sea, especially from deep water had by that time ceased to show any exudation when cut.

3. I commenced operations by closing the pond on November the 21st. On November the 29th the water inside suddenly became very blue and did not recover its normal appearance until December the 3rd. No such change had ever been noticed before. On December the 9th young oysters of the size of pinheads were found on some of the collectors near to the breeding-stock trays. On December the 29th another batch appeared, and a still more copious batch on January the 3rd, and doubtless others occurred which were not noticed. These young oysters in shape would pass either for pearl-shells or bastard-shells and the byssus attachment was visible with the glass. They varied in number on each stone collector up to fifty or sixty. Every effort was made to rear them, some in the pond and some slung in cages in the open tideway; but without success, as they quickly began to disappear, and within a fortnight or so each batch had completely vanished. There were no fragments of shell left and they must deliberately have detached themselves and probably fell into the film of mud or sediment at the bottom and were smothered or devoured by bottom vermin. On February the 6th, a hurricane blew my house into the sea and I lost everything in it, including the mounted specimens of these young oysters. No further notes were taken as to what was going on in the pond, but numerous other batches of young shells probably came into existence and disappeared in like manner.

4. Here and there about the pond I found an odd shell on the collectors, of much larger growth, widely

scattered. These were kept under observation in the pond under similar conditions as the pinhead shells. None of them showed any disposition to shift although they were frequently handled, and when I opened them on the 9th April, the colour of the animal within showed them to be bastard-shells as I suspected.

5. True pearl-shells are not found on hard rock bottom, but "reef" or bastard-shells are very commonly so found. I submit that the pinhead oysters were true pearl-oysters attached to stone for want of a better place, and that they shifted in search of one; whereas the others which proved to be "reef" shell did not shift. The reef-shells must undoubtedly have come in with the tide-water and they were widely separated. I contend that if the pinhead oysters came in with the tide inrush of water they, too, would not have been found congregated thickly together, but would have been scattered more generally over the pond. Consequently, I claim that they were the progeny of my parent stock in the pond. Dr. Jameson is of a contrary opinion, but Mr. Dannevig is not so. His Report to the Minister on his interviews with me in Melbourne last year, has been laid before the Royal Commission, therefore I may fairly be allowed to quote from it as follows:

"He (Mr. Haynes) is unable to positively say the 'brood' were genuine pearl-oysters, as they were too small for identification, but the inference that they were is very strong."

6. Regarding paragraph two, Dr. Jameson does not think that any of the breeding stock which was undoubtedly showing signs of spawning in November, ever discharged any portion of their products, ova or milt, in the pond at all, and that they had not done so even at the end of March, when they were still surcharged, and he is of opinion that the female discharges the whole of her eggs in the course of a few hours. If this is so, her period of preparation—five months—seems a very long one and with all deference to my friend, Dr. Jameson, I venture to doubt it. Moreover, that argument leaves untouched the facts that the pinhead oysters were closely congregated and would not stay on the stones, whereas the young reef-shells were found singly, the total number was very small, and they stayed where they were.

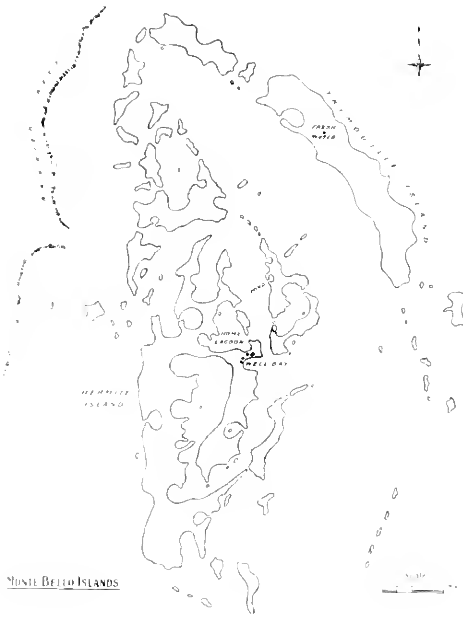


Figure 505.
A Chart of the Montebello Islands.

The Montebello operations were closed after the hurricane, partly for want of funds and partly because, in the absence of any security of tenure and a previous cancelment of the lease in 1906 by the Newton Moore Government, it was impossible to obtain or even ask for any further support. It has been reserved for a Labour Ministry at last to do justice to the case, and the difficulty of security of rights is now being removed. The operations ought soon to be resumed, but nothing can be done before the spatting season commencing in November, 1913, beyond the work of preparation and the putting up a new homestead. The problem of rearing the young shells may take as long a time to solve as that of lobsters, in 1898, in the hands of the United States Fisheries Commission, and a constant circulation of water by artificial means may similarly be required. Seven years may possibly be absorbed before marketable shell can be produced, and the venture turned into a commercial success: in no case can it be less than four years, and the amount of money required is so considerable that it will be extremely difficult to find English supporters; but the possibility of financial assistance being accorded by the West Australian Government may facilitate matters. It is impossible, however, to leave Dr. Jameson's challenge unmet.

One subject only remains to be dealt with here. Dr. Jameson has pointed out that cultivation of pearl shell is directly opposed to the interests of the owners of the pearling fleets now in existence. Mr. Male, the member for Broome, the pearling port, criticised the new Pearling Bill, and amongst other things he maintained that the great North-West pearling grounds were unsuitable for cultivation purposes and he could not think of a single place which was sufficiently protected.

The chart of the Montebello Islands will show that sheltered ground exists there to an ideal extent that is unequalled, to my knowledge, in any part of the world, and the pearl-shells found there, weighing up to fifteen pounds apiece, are the finest in the

Sould. The only disadvantage [illegible] that the islands lie ninety miles from the mainland, that there is no mail communication with the [illegible], they are uninhabited. Dr. Jameson [illegible] why Saville-Kent wanted to grow pearl-shell at the Abrolhos, far south of their natural habitat. I can tell him! Kent found that [illegible] a warm water current, and conceived [illegible] that pearl-shells might do there. He [illegible] concession rights there and tried to [illegible] company in London for £100,000, and induced me to put my name to it. After a week's reflection, however, I withdrew my name, as the closer I studied it the less I liked it—and the Company was never formed. The project could have been worked very comfortably from the town of Geraldton, not far distant; but the want of sheltered waters and of any large extent of mud bottom to afford a large food supply was alone sufficient to deter a prudent man from encouraging the idea.

REVIEWS.

PHOTOGRAPHY.

Telephotography.—By CYRIL F. LAN DAVIS, F.R.P.S. [illegible] 16 full-page plates and 7 diagrams. 7¼ ins. × 5¼ ins.

(George Routledge & Sons. Price 2/- net.)

The author of this book has produced a useful and interesting little volume dealing with the subject of Telephotography, and one which should be extremely valuable to the practical worker. The work not only deals with the subject in its relation to distant objects, but explains in an equally clear manner its value in photographing near ones, an important application frequently lost sight of. In explaining the advantages of the Telephoto system for distant objects, comparison is drawn between the size of the images given by a five inch and twenty-inch focus lens respectively, and then it is shown how by the use of a Telephoto combination consisting of a five-inch positive and a two and a half-inch focus negative lens, and seven and a half inches of camera extension, the size of the image would be the same as that given by a twenty-inch focus lens and requiring practically that extension of camera. The Telephoto lens thus places the means at our disposal of obtaining large pictures with only small extension of camera. In discussing the use of these lenses for near objects, the author gives an example in which the camera extension is only a little more than half that required by an ordinary lens for the same size of image, with the object several feet further off, thus giving improved perspective. Examples are also given of rapid Telephoto lenses which are mostly of fixed focus, and so only give one degree of magnification for distant objects. The large Adon manufactured by Messrs. J. D. Dallmeyer is of this type and works at from F. 4·5, F. 6 to F. 10, and is supplied in focal lengths suitable for obtaining pictures of from two to four times the usual size, and can be employed on reflex cameras where the image is focused up to the moment of the exposure. Some interesting remarks are also made regarding the exposure required for distant objects. Theoretically, this should be proportional to the square of the magnification, but practice has shown that it is better to take one-half of this when working without a screen, and only give the full time when using a properly-adjusted light filter. The book, which is clearly written, contains numerous examples illustrating the various applications of Telephotography, as well as carefully compiled working data, and should certainly be studied by all those interested in this branch of photographic work.

E.S.

ZOOLOGY.

Reptiles, Amphibians, Fishes, and Lower Chordata.—By RICHARD LYDEKKER, J. T. CUNNINGHAM, M.A., G. A. BOULENGER, D.Sc., F.R.S., and J. ARTHUR THOMSON, M.A. 510 pages, 4 plates in colour, 23 in monotone, 1 map, and many text figures. 9-in. × 6-in.

(Methuen & Co. Price 10/6 net.)

This volume is a companion one to a History of Birds written by Mr. W. P. Pycraft, the general editor of the series, but as it deals with Reptiles, Amphibians, and lower Chordata; it is the joint work of several well-known naturalists and it has been edited by Mr. J. T. Cunningham. The volume is by no means an ordinary text book and it deals with Natural History in a general sense rather than with classification. We find discussed in detail, adaptations, coloration and its interpretation, life-histories and modes of reproduction. The consideration of reptiles gives an opportunity of tracing their pedigrees and relationship. Under the heading of Fishes, the phenomena of sex are dealt with, as well as the production of sound, light and electricity. In every way this is a modern book, written, produced and illustrated in a modern way.

W. M. W.

NOTICES.

CORRECTIONS. Mr. Henry Faulds points out that there is a mis-spelling on page 440, namely "Hari-kari," for the Japanese "Hara-kiri." He believes that the first form has got into some dictionaries, but it is absolutely wrong.

In Mr. Redgrove's review of Dr. Dakin's book, an addition made by him on his proof was inserted at the wrong point. In the sixth line from the bottom of the review on page 442, for "in the body" read "when perfused through a surviving liver," and next line for "when perfused through a surviving liver" read "is produced."

MR. LEITZ HONOURED. Recently the Faculty of Medicine of the University of Giessen conferred the honorary degree of Doctor of Medicine upon Ernst Leitz, Junior, the junior partner of the celebrated optical firm of E. Leitz, of Wetzlar, and 18, Bloomsbury Square, London.

It is only a little more than a year since the University of Marburg honoured the senior partner of the same firm by conferring upon him the degree of Doctor of Philosophy.

We congratulate Messrs. Leitz on the fact that their services to Science have been so properly and suitably recognised.

MR. EDWARD BAKER'S CATALOGUE.—We have received the three-hundred and fourth catalogue of more than one thousand books on sale at Edward Baker's Great Book-Shop, Birmingham. Among them are many first editions, limited issues, and presentation copies, as well as a number of American Transactions.

THE "LONDON" MICROSCOPE.—Our readers will be interested to hear that Messrs. R. & J. Beck, Ltd., have produced a new microscope. A special feature of it is the large and heavy base, which ensures perfect rigidity when it is in a horizontal as well as in a vertical position. There is a specially smooth-working and reliable fine adjustment, while the stage is four inches square, and the instrument is finished in Messrs. Beck's special black enamel which withstands the actions of acids and spirit.

BOTANICAL WORKS.—We are pleased to draw attention to Messrs. John Wheldon & Co's. handily arranged catalogue of botanical books. The contents are arranged under three main headings: Economic, Geographical, and General. Each of these is again sub-divided so that the list referring to any particular branch of botanical science can easily be consulted.